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ACTA RADIOLOGICA
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VOL. XIV FASC. 6 30: XII 1933 N:o 82

DIE ANATOMISCHE GRUNDLAGE DES RÖNTGENBILDES DER SOGEN. »ERWORBENEN HIATUSBRÜCHE»[1]

von

Åke Åkerlund

Auf dem IV., im September 1925 zu Helsingfors abgehaltenen Kongress der Nordischen Gesellschaft für Medizinische Radiologie hatte ich Gelegenheit, über die Röntgendiagnostik der Hiatusbrüche zu berichten. Im folgenden Jahre publizierte ich meine Erfahrungen in dieser Frage ausführlicher in der Festschrift für FORSSELL (Bd. VI der Acta Radiologica) und referierte sie im Frühling desselben Jahres auf dem Deutschen Röntgenkongress in Berlin. Dass ich dasselbe Thema jetzt nach 8 Jahren neuerlich auf einem Nordischen Röntgenkongress wiederaufgreife, hat seinen Grund in der lebhaften Diskussion, die die sogen. »erworbenen Hiatusbrüche», hauptsächlich in Deutschland, in der letzteren Zeit, ganz besonders im letzten Jahre, veranlasst haben.

Ich nahm an, dass es für die geehrte Versammlung vielleicht von Interesse sein würde, einerseits einen kurzen Überblick über einige neuere, die Anatomie des Hiatustraktes bei normalen und pathologischen Verhältnissen behandelnde Arbeiten zu hören, die in der letzten Zeit von verschiedenen Seiten als Resultat des durch die röntgenologische Hiatusbruchdiagnostik wiedererweckten Interesses für diese Region veröffentlicht wurden, und anderseits einen Bericht über die autoptischen Beobachtungen entgegenzunehmen, die bisher an meinem Material von röntgendiagnostizierten Hiatusbrüchen gemacht wurden.

Was zunächst den *Namen »Hiatusbruch»* betrifft, den ich in meiner

[1] In verkürzter Form vorgetragen am Kongress der Nord. Ges. f. Med. Radiologie im Juni 1933 in Stockholm.

Bei der Redaktion am 15. IX. 1933 eingegangen.

Aus der Röntgenabteilung des Maria Krankenhauses zu Stockholm. Chef: Dr. Med. Åke Åkerlund

soeben erwähnten Arbeit für mehr oder weniger beträchtliche, *aufwärts durch den Hiatus oesophageus erfolgende abdomino-thorakale Verschiebungen des abdominalen Ösophagusteiles und der angrenzenden Magenpartie* vorschlug, konnte ich mit Befriedigung konstatieren, dass dieser Name in der Röntgenliteratur so gut wie allgemein angenommen worden ist.

In meiner oben erwähnten Arbeit teilte ich die Hiatusbrüche, je nach dem Verhalten des distalen Ösophagusendes, *in drei Gruppen* ein, und auch diese Gruppeneinteilung wurde später von der Mehrzahl der Verfasser angewendet (Fig. 1).

Die Gruppe I umfasste die Fälle mit (*kongenital*) *verkürztem Ösophagus*, bei welchen Ösophagus und Magen *nicht* in der gewöhnlichen Weise in die Bauchhöhle hinabgestiegen sind.

Gruppe II enthielt die *paraösophagealen* Brüche im eigentlichen Sinne, bei welchen der Ösophagus in normaler Weise in die Bauchhöhle hinabgestiegen und nicht selbst in dem Bruch enthalten ist, der vielmehr neben ihm liegt.

Gruppe III umfasste die übrigen Fälle, bei welchen der Ösophagus nicht verkürzt ist aber die Pars abdominalis oesophagi selbst an der Herniierung beteiligt ist.

Bei Gruppe I ist das *distale Ösophagusende* also niemals in die Bauchhöhle hinabgestiegen, bei Gruppe II ist der Descensus erfolgt, und das Ösophagusende liegt immer noch in der Bauchhöhle, bei Gruppe III ist es hinuntergestiegen, aber später wieder nach oben aus der Bauchhöhle hervorgedrängt worden.

Die beiden ersten Gruppen sollen nach der allgemein akzeptierten Ansicht mit Entwicklungsstörungen zusammenhängen, man pflegt sie deshalb als *kongenitale Formen* zusammenzufassen; sie sind seltene Erscheinungen und haben kaum Meinungsverschiedenheiten veranlasst.

Gruppe III dagegen, bei der das distale Ösophagusende im Bruch enthalten ist, hat sich — in Übereinstimmung mit meiner früher vorgebrachten Auffassung — in voll entwickelter Form besonders bei älteren Individuen als eine relativ häufig vorkommende Veränderung erwiesen. Aus guten Gründen ist man nunmehr mit SCHATZKI der Ansicht, dass sie *akquiriert* ist. Die Diskussion drehte sich hauptsächlich um diese Form, und ich werde mich im folgenden nur mit ihr befassen.

Bevor ich näher auf die anatomischen Hiatusuntersuchungen eingehe, muss ich mich erst etwas bei der Bedeutung der *röntgenologischen Untersuchungstechnik* für den Nachweis einer solchen Verschiebung aufhalten, die das distale Ösophagusende, eventuell auch die angrenzende Magenportion, nach oben durch den Hiatus oesophageus durchmacht.

Über die Methodik ist zu sagen, dass es zwei, prinzipiell verschiedene Wege gibt, einen Hiatusbruch mit Kontrast zu füllen, nämlich entweder

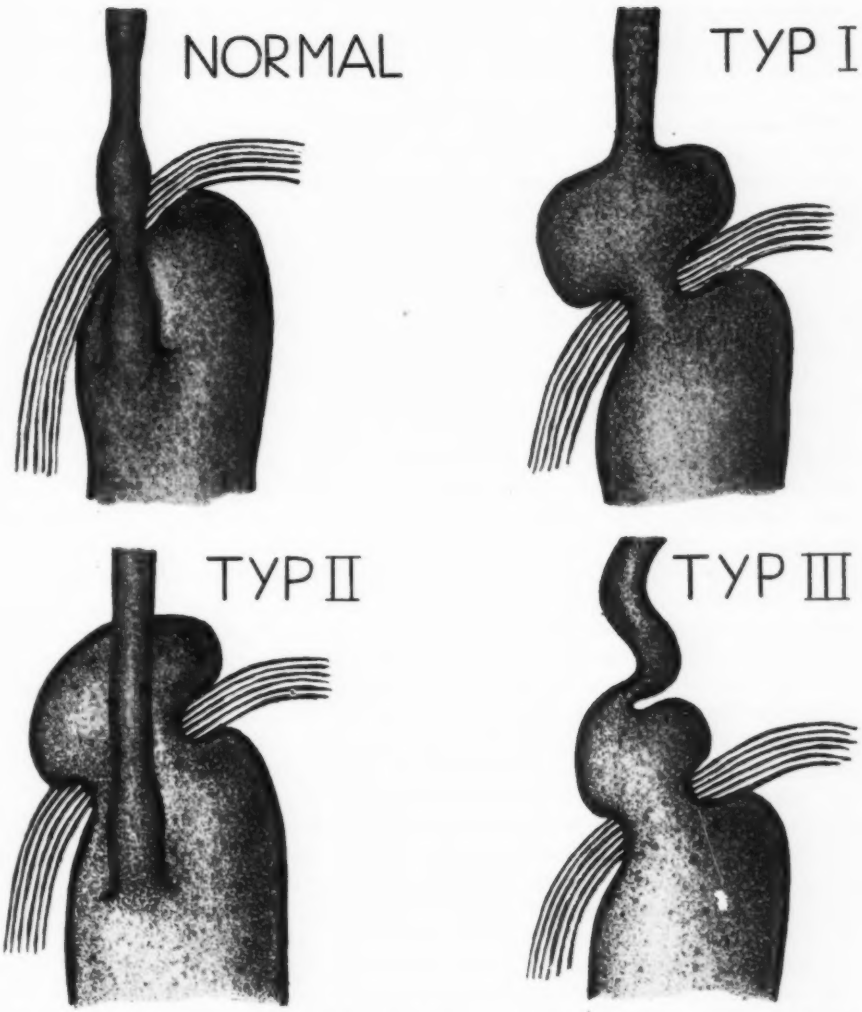

Fig. 1. *Einteilung der Hiatusbrüche.* Auf dem normalen Vergleichsbilde markieren sich die beiden ampullären Erweiterungen des distalen Ösophagusendes: »Ampulla phrenica« *oberhalb* und »Antrum cardiacum« *unterhalb* vom Zwerchfell. Die verschiedenen Typen des Hiatusbruches: Typ I (Hiatusbrüche mit kongenitaler Ösophagusverkürzung). Typ II (paraösophageale Hiatusbrüche). Typ III (Hiatusbrüche von sogen. »akquiriertem Typus«).

von unten, zunächst von einem schon kontrastgefüllten Magen, oder *von oben*, direkt von Ösophagus.

Die ersterwähnte Füllungsmethode lässt sich am einfachsten an die gewöhnliche Alltagsmethode der röntgendiagnostischen Magenuntersuchung anschliessen; mit dieser Methode kann man allerdings in der Regel nicht die allerersten und denkbar kleinsten Anfangsstadien der Hiatusbrüche sichtbar machen, wohl aber die ausgesprochenen, zweifellosen, meiner Ansicht nach klinisch wichtigeren Fälle.

Beim zweiten Füllungsweg, direkt vom Ösophagus, hat man die Kontrastfüllung sozusagen mehr in seiner Hand, man kann das Hiatusstudium bis an die äusserste erreichbare Grenze treiben, und die frühesten — aber klinisch vielleicht bedeutungsloseren — Verschiebungen durch den Hiatus nachweisen, natürlich unter der Voraussetzung eines sorgfältigen Durchleuchtungsstudiums der verschiedenen Phasen des Schlingaktes.

Ich selbst habe, wie aus meiner oben erwähnten Arbeit ersichtlich ist, vom Anfang an so gut wie ausschliesslich die Methode der Füllung *vom Magen* aus angewendet und bediene mich aus praktischen Gründen auch weiter vorzugsweise dieses Weges. Patienten, die aufrechtstehen können, nehmen die Kontrastmahlzeit in aufrechter Körperstellung zu sich; beim Hinunterschlucken sieht man in dieser Stellung meistens nichts Bemerkenswertes in der Hiatusregion, wenn es sich nicht um einen besonders grossen Hiatusbruch handelt. Dass sich der Ösophagus bei stehender Stellung auch bei einem Hiatusbruch meistens vollständig entleert, kann in verschiedenen Fällen verschiedene Erklärungen haben: In gewissen Fällen ist die Organdislokation bei dieser Stellung aufgehoben, in anderen Fällen passiert das Kontrastmittel den dislozierten Organteil, ohne eine auffallende Form- oder Passagestörung zu veranlassen. Hat der Patient liegende Stellung eingenommen (Rücken- oder Bauchlage), so füllt sich der Hiatusbruch *vom Magen aus* mit Kontrast, oft spontan, mitunter erst nach Beckenhochlage oder Bauchkompression, *aber ohne Einnehmen einer weiteren Kontrastmenge in liegender Stellung*. Hat sich der Bruch einmal gefüllt, so bleibt die Kontrastfüllung in der Regel — wenn der Patient nicht die Lage ändert — so lange bestehen, dass man genügend Zeit hat, den Bruch sowohl durch Durchleuchtung als auch durch Exponierungen zu analysieren.

Berg und besonders Knothe haben die Untersuchungstechnik des Hiatustraktes bei *Kontrastfüllung von oben* besonders ausgebildet. Nach Knothe führt man die Untersuchung bei Rückenlage aus, lässt den Pat. eine relativ dicke Bariumsuspension einnehmen und verfolgt genau deren Passage in der Hiatusgegend mittels Durchleuchtung, die mit »gezielten Serienaufnahmen» kombiniert wird. Der Schlingakt selbst muss *bei ruhigem unbehindertem Atmen* studiert werden. Als unerlässliche Bedingung gilt, dass alle Momente vermieden werden, die Stagnation im unteren Ösophagusteile mit dadurch bedingten vorübergehen-

den Kontraktionsphänomenen und abnormen Füllungsverhältnissen verursachen. KNOTHE warnt bei Verwendung des direkten ösophagealen Füllungsweges ausdrücklich vor allen mechanischen Momenten, die eine Schliessung des Hiatus, »Hiatussperre», mitsichbringen: tiefe Inspirationsstellung, aktives Pressen des Patienten oder passive Kompression des Bauches.

Seit BARSONYs Hinweis im Jahre 1928 sind den Röntgenologen die physiologischen, oft pflaumengrossen Abschnürungen des Ösophagusschattens der alleruntersten, *intrathorakalen* Partie wohlbekannt, die bei verstärkter Ösophagusperistaltik während des Schlingaktes auftreten können. Diese Abschnürungen können, wie BARSONY hervorhob, weiter und breiter werden als der übrige Ösophagusschatten, und können während des Bestehens gewisser, rasch vorübergehender peristaltischer Momente *den Eindruck eines Hiatusbruches machen*, weshalb BARSONY sie »Pseudohernien» nannte. Diese ampullären Ösophaguserweiterungen entsprechen, worauf SCHATZKI später hinwies, vollständig der schon im Jahre 1905 von HASSE und STRECKER beschriebenen normalanatomischen »Ampulla phrenica». Die Fehldeutung solcher »Pseudohernien» wird durch genaue Durchleuchtung bei ruhiger kontinuierlicher Atmung vermieden.

Zusammenfassend kann man über die beiden Füllungswege für einen Hiatusbruch sagen, dass der *Weg über den Magen* eine etwas grobe, aber leicht in den Rahmen des übrigen gewöhnlichen Untersuchungsganges einzufügende Methode ist, die eine für praktisch-klinische Zwecke ziemlich ausreichende Orientierung liefert. Der *direkte ösophageale Füllungsweg*, der eine weitere Verfeinerung der Hiatusdiagnostik ermöglicht, hat natürlich immer seine grosse wissenschaftliche und theoretische Bedeutung, erfordert aber anderseits eine zeitraubende Durchleuchtungsarbeit und kann, von einem weniger geübten Untersucher ausgeführt, zu Fehldeutungen führen, wenn es sich um die Anfangsstadien der Hiatusbrüche, die sogen. »Hiatusinsuffizienzen», handelt, deren klin. Bedeutung gegenwärtig ziemlich umstritten ist.

Die *Anatomie der Hiatusregion* hat in der letzteren Zeit erneutes Interesse auf sich gelenkt.

Von den seit altersher bekannten normal-anatomischen Details verdient eigentlich nur ein Umstand in diesem Zusammenhange besonders hervorgehoben zu werden, da er von spezieller Bedeutung für die Auffassung über die Anfangsstadien der erworbenen Hiatusbrüche ist. Ich meine damit das *Verhalten des Peritoneums* zum Hiatus, zum Ösophagus und zum angrenzenden Teil des Magens.

Unter Hinweis auf das erschöpfende Bildermaterial der anatomischen Handbücher (z. B. desjenigen von TESTUT und JACOB, von CUNNINGHAM sowie von CORNING) möchte ich an die wohlbekannte Tat-

sache erinnern, dass der hintere Umfang der Pars abdominalis oesophagi, der LUSCHKA im Jahre 1857 den Namen »Antrum cardiacum» gab, der angrenzende Teil der hinteren Magenwand und ein begrenztes Gebiet des Diaphragmas, das unmittelbar unterhalb und links vom Hiatus liegt, keine Peritonealbekleidung haben.

Das Ausmass, in welchem die Pars abdominalis oesophagi und der Ventrikelfornix Peritonealbekleidung entbehren und nur durch lockeres Bindegewebe von den gleichfalls peritoneumlosen, an den Hiatus grenzenden Diaphragmapartien getrennt sind, scheint individuell verschieden zu sein. Man muss daran festhalten, dass *ein unmittelbar unterhalb vom Hiatus gelegener Teil des Ösophagus und der Ventrikelfornix tatsächlich extraperitoneal resp. retroperitoneal liegen.* Solange eine auftretende Organverschiebung nach oben gegen die Thoraxhöhle durch einen erweiterten Hiatus nur diese extraperitonealen Organpartien umfasst, kann man natürlich nicht erwarten, dass sich ein peritonealbekleideter Bruchsack auszubilden vermöchte — in voller Analogie mit den Verhältnissen bei den wohlbekannten bruchsacklosen *extraperitonealen* und *retroperitonealen* Brüchen (beispielsweise den bruchsacklosen Blasen- und Lumbalbrüchen). Ebensowenig ist man berechtigt, einen Bruchsack zu erwarten, so lange sich die locker befestigte Peritonealbekleidung von den aus der Bauchhöhle austretenden Organteilen im selben Masse abwickelt, wie diese durch die Bruchpforte, in diesem Falle nach oben durch den Hiatus, hinausgedrängt werden, mit anderen Worten, so lange parallel der Herniierung eine viszerale »Deperitonisierung» stattfindet, die dem beim Gleitbruchmechanismus erfolgenden Abgleiten des Parietalperitoneums nahe verwandt ist.

Über die normale Muskelanatomie des Hiatus oesophagei wurde ganz kürzlich von KOEPPEN und FRANK (1933) eine grössere anatomische Untersuchung ausgeführt. Die Verf. präparierten in 50 Fällen die Hiatusmuskulatur und fanden 3 verschiedene Typen der muskulären Begrenzung des Hiatus: Die Muskelfasern am Crus mediale, die den Hiatus begrenzen, kreuzen einander vor dem Ansatz am Centrum tendineum (Muskeltyp I) oder konvergieren, ohne sich zu kreuzen, gegen den Ansatz am Centrum tendineum (Muskeltyp II), oder sie nehmen einen rein divergenten Verlauf gegen den Ansatz am Centrum tendineum (Muskeltyp III).

Auch die Frage der *Verschiebbarkeit des Ösophagus innerhalb des Hiatus* war kürzlich Gegenstand der Diskussion.

Im Gegensatz zur herrschenden anatomischen und chirurgischen Auffassung hoben SAUERBRUCH, CHAOUL und ADAM (Sept. 1932) in einer Arbeit mit dem Titel: Anatomisch-klinischer und röntgenologischer Beitrag zur »Hiatushernie» in der D. M. W. hervor, der Ösophagus sei vorn und an den Seiten durch breite Muskelbündel ausserordentlich fest an den Hiatus fixiert.

In keinem einzigen ihrer obenerwähnten Fälle und auch nicht bei den in situ fixierten und in verschiedenen Ebenen geschnittenen Präparaten konnten KOEPPEN und FRANK (1933) trotz aller Mühe makro- oder mikroskopisch eine einzige solche Muskelfaser nachweisen.

Auch ANDERS und BAHRMANN, die Ende des Jahres 1932 sehr genaue und umfangreiche makro- und mikroskopische anatomische Untersuchungen über die Hiatusregion publizierten, konnten keine solche muskuläre Fixation beobachten.

NEUMANN, der im April 1933 eingehende anatomische Hiatusuntersuchungen veröffentlichte, die sich auf Untersuchungen in situ an 250 Fällen gründeten, von welchen 100 genau präpariert wurden, sagt über die angebliche muskuläre Fixation des unteren Ösophagusendes an den Hiatus ausdrücklich: »Eine Muskelplatte oder ein Muskelkegel wird nicht beobachtet.» Dagegen findet sich nach NEUMANN im Hiatusgebiet ein gut ausgebildetes »elastisches Hiatuszwischengewebe.»

Nach ANDERS erhält der Ösophagus eine sehr elastische Fixation am Hiatus durch eine aus drei Schenkeln bestehende *Membrana elastica diaphragmatico-oesophagealis*, die als eine Art elastische Sehne bezeichnet werden kann, mit einer doppelten Aufgabe: einerseits dem Ösophagus eine relative Ruhelage bei den respiratorischen Zwerchfellexkursionen zu bereiten und zu starke Längskontraktion des Ösophagus beim Schlingakt zu verhindern, anderseits durch Hinaufpressung des von ANDERS nachgewiesenen normalen »*subdiaphragmalen Fettringes*» in den Hiatus diesen zu dichten.

KOEPPEN und FRANK (1933) untersuchten an 120 Leichen die Verschiebbarkeit des Ösophagus im Hiatus bei ungestörten natürlichen Lageverhältnissen und stellten Resultate dieser Untersuchungen in einer Tabelle zusammen. 97 Fälle zeigten eine Verschiebbarkeit von höchstens 1 cm, 23 Fälle eine von mehr als 2 cm, 6 von diesen letzteren eine grössere als 4 cm. Nach Ansicht der Verfasser ist ihr Material noch zu klein um zu entscheiden, ob das Alter einen bestimmten Zusammenhang mit der erhöhten Verschiebbarkeit hat, die Resultate sprechen jedoch für einen solchen Zusammenhang.

Auch die *normale Lage der Kardia* wurde in der letzten Zeit in Diskussion gezogen. Die seit altersher angenommene normale Lage der anatomischen Kardia unterhalb vom Diaphragma wurde im letzten Jahre bestritten. SAUERBRUCH, CHAOUL und ADAM (Sept. 1932) erklärten kategorisch: »In diesem Schrägkanal (des Hiatus) liegt die eigentliche anatomische Kardia.»

Auch in diesem Punkte haben sowohl ANDERS' und BAHRMANNS als auch NEUMANNS obenerwähnte, genaue anatomische in-situ-Untersuchungen über die Hiatusregion Klarheit geschaffen. ANDERS unterscheidet eine Cardia anatomica, der er den Beinamen inferior gibt, und

eine Cardia diaphragmatica, die er superior nennt. *Die Cardia inferior anatomica* befindet sich an der Grenze zwischen der Ösophagus- und Magenschleimhaut und liegt normalerweise *unterhalb* vom Hiatus. Die *Cardia superior diaphragmatica* ist normalerweise im Hiatus selbst gelegen und besteht aus einer sphinkterförmig verdickten Muskelmanschette der Ösophagusmuskulatur. Durch diese Anordnung ergibt sich unter normalen Verhältnissen eine »doppelte Sicherung» zwischen Magen und Ösophagus an zwei topographisch geschiedenen Stellen, der oberen am Hiatus, der unteren am Platze der Ora serrata.

NEUMANNS anatomische Hiatusuntersuchungen gaben in der Hauptsache ein damit übereinstimmendes Resultat. Normalerweise liegt das ganze Antrum cardiacum (LUSCHKA, 1857) *unterhalb* vom Zwerchfell (in 87 ½ % aller Fälle); in mehr als der Hälfte von sämtlichen Fällen liegt die anatomische Kardia (d. h. die Ora serrata) an der unteren Grenze des Antrum cardiacum, d. h. an der von der Incisura cardiaca (HEISTER, 1752) ausgehenden *Arnold*schen Furche, in den übrigen Fällen höher oben im Antrum cardiacum in rasch abnehmender Prozentzahl.

Die *Arnold*sche Furche hat ihre strukturelle Grundlage in der starken »Raphe-Bildung», die wir aus FORSSELLS eingehenden Untersuchungen über die Kardiamuskulatur kennen.

Wir verlassen nun die Normalanatomie und gehen auf den *Entstehungsmechanismus und den Entwicklungsmodus der erworbenen Hiatusbrüche* über, wie man sie sich nach den umfangreichen anatomischen in-situ-Untersuchungen des Hiatusgebietes vorstellen kann, die ANDERS und NEUMANN unabhängig voneinander ausführten, jeder von ihnen mit seiner speziellen Sektionstechnik.

Wie soll man sich nun die Gestaltung der *Anfangsstadien* einer erworbenen Herniierung durch den Hiatus vorstellen?

Die folgenden Momente müssen die Entstehung einer Organverschiebung nach oben durch den Hiatus begünstigen:

Dehnung des Hiatus, Insuffizienz seiner *muskulären* Begrenzung.

Reduktion des dichtenden *Fettgewebes* im Hiatus (ANDERS: »Subdiaphragmaler Fettring»).

Verringerte Elastizität des *elastischen* Hiatusgewebes (ANDERS: »Membrana elastica diaphragmatico-oesophagealis», NEUMANNS: »elastisches Hiatuszwischengewebe»).

Auflockerung des periösophagealen resp. subperitonealen *Bindegewebes*, die zu einer erhöhten Verschiebbarkeit zwischen Peritoneum und den darunterliegenden Teilen des Digestionskanales führt.

Steigerungen des positiven intraabdominalen und negativen intrathorakalen Druckes verschiedener Art: Intensive, dicht aufeinanderfolgende und langdauernde Hustenattacken, anhaltende Brech-

und Pressbewegungen, Meteorismus, chronische Obstipation, Bauchtumoren, Aszites, wiederholte Graviditäten, chronisches Lungenemphysem, chronische Bronchitis, Asthma.

Unter Einwirkung solcher Faktoren beginnt sich zuerst die Pars abdominalis oesophagi (Antrum cardiacum, Epicardia), sodann der angrenzende Magenteil allmählich durch den Hiatus nach oben auszustülpen. Anfänglich ist die Dislokation nur momentan oder jedenfalls mehr vorübergehenden Charakters und tritt nur unter solchen Verhältnissen und bei solchen Körperstellungen auf, die sie begünstigen, also vorzugsweise in liegender Stellung; erst in späteren Entwicklungsstadien kann die Dislozierung mehr permanent werden.

Bei den frühesten Dislokationsstadien, solange nur das Antrum cardiacum und der nächst angrenzende Teil des Magens durch den Hiatus nach oben geschoben ist, bildet sich kein Bruchsack aus (vgl. das oben, bei Erörterung der normalen Anatomie des Peritoneums gesagte). *Die Organverschiebung verläuft nämlich anfänglich in der Regel — wie die Erfahrung jetzt gezeigt hat — unter dem Typus eines bruchsacklosen Bruches* (vgl. die bruchsacklosen extraperitonealen Brüche und den bruchsacklosen Typus der Gleitbrüche). *Erst wenn sich ein grösserer Teil des Magens durch den Hiatus nach oben verschoben hat, beginnt sich gewöhnlich auch ein Bruchsack auszustülpen* (siehe Fig. 2).

Der oben skizzierte Entwicklungsmechanismus der erworbenen Hiatusbrüche scheint mir in allen Punkten sowohl in ANDERS und BAHRMANNS als auch in NEUMANNS morphologischen Hiatusuntersuchungen die denkbar beste Stütze zu haben.

Als ich in meiner früheren Publikation in dem auf die damals zugänglichen Literaturfälle basierten pathol.-anat. Teil hervorhob, dass die Hiatusbrüche im allgemeinen einen Bruchsack hätten, so betraf dies, wie aus dem Zusammenhang deutlich hervorging, die bis dahin operierten und bis dahin bei der Sektion nachgewiesenen Fälle, bei welchen es sich aus leicht erklärlichen Ursachen um vollständig ausgebildete grosse oder mittelgrosse Brüche handelte.

ANDERS ist der Ansicht, dass diese Ausstülpungen abdominaler Organteile durch den Hiatus nach oben zum Thorax, so lange kein Bruchsack vorliegt, nicht den Namen wirklicher Brüche verdienen; er schlägt vielmehr als Benennung vor: »epiphrenale Glockenbildung« oder »Hiatusinsuffizienz mit thorakaler Dystopie des Antrum cardiacum« und eventuell auch angrenzender Magenteile.

Auch NEUMANN will diesen Hinaufschiebungen des Antrum cardiacum (ev. mit angrenzenden Teilen des Magens) über das Zwerchfell, die er mit spezieller Sektionstechnik bei 12 % seines grossen, nicht besonders ausgewählten Materials an 250 in-situ-Untersuchungen nachwies,

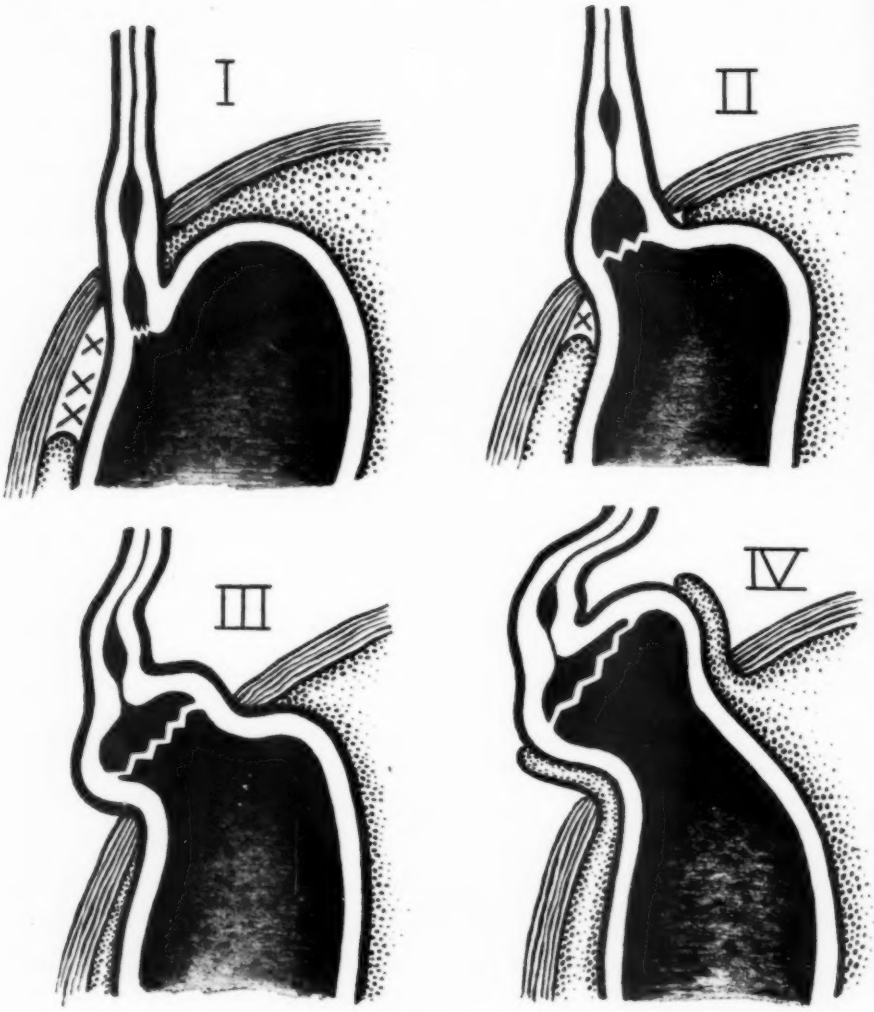

Fig. 2. *Der Entstehungsmechanismus der ›akquirierten‹ Hiatusbrüche.*

I: Normalanatomisches Ausgangsbild, das die Ampulla phrenica, das Antrum cardiacum und die Zick-Zack-Linie der Ora serrata zeigt. Die Peritonealhöhle ist durch das punktierte Gebiet markiert; in dem mit ›×‹ bezeichneten Gebiet fehlt die Peritonealbekleidung.

II und III: Das bruchsacklose Anfangsstadium des Hiatusbruches, in dem zuerst nur das Antrum cardiacum und später auch angrenzende Teile des Magenfornix ausgestülpt werden.

IV: Völlig ausgebildeter Hiatusbruch mit ausgestülptem Peritonealrezess (Mit Bruchsack versehener Hiatusbruch).

aus derselben Ursache wie ANDERS nicht die Bezeichnung Bruch geben, nämlich darum, weil in diesen Fällen oberhalb vom Zwerchfell keine Peritonealbekleidung beobachtet wurde. NEUMANN schlägt stattdessen den Namen »Bulbusbildung» (Bulbus antri cardiaci) vor.

Ich für meinen Teil meine, es hiesse den Bruchbegriff zu eng fassen, wenn man diese Verschiebungen nicht Herniierungen nennen sollte. Es handelt sich ja doch darum, dass ein normalerweise der Bauchhöhle angehörender Organteil aus dieser durch eine (präformierte) Öffnung in der muskulären Begrenzung des Abdomens austritt. Es ist ja das erste Stadium desselben kontinuierlichen Gleitprozesses, das in seiner vorgeschrittenen Form zu typischen Hiatusbrüchen im reinsten Sinne des Wortes führt. Will man genau sein, so kann man diese ersten Stadien von Ausstülpung durch den Hiatus vom pathol.-anat. Gesichtspunkte gern ein allererstes *bruchsackloses Anfangsstadium der Hiatusbrüche* oder ganz einfach *»kleine bruchsacklose Hiatusbrüche»* nennen. Jedenfalls werden diese Anfangsstadien vom klinisch-röntgenologischen Standpunkte sicherlich weiter schlechtweg den Namen *»kleine Hiatusbrüche»* behalten, so lange wir nicht ohne operative oder postmortale Autopsie direkt beobachten können, ob sich schon ein Bruchsack ausgebildet hat oder nicht, sondern nur den Grad der Organverschiebung röntgenologisch nachzuweisen vermögen. Diese Organausstülpungen verdienen, scheint mir, — auch in den Anfangsstadien — den Namen »echte Brüche» mit demselben Recht wie andere Arten bruchsackloser Brüche, die ihn nach altherkömmlichem Brauch führen (Vgl. z. B. BUMM: Die äusseren Abdominalhernien 1931, Abb. 68 und 78 sowie S. 313).

Was nun die *Frequenz* der akquirierten Hiatusbrüche betrifft, so haben die gehäuften übereinstimmenden röntgenologischen und pathologisch-anatomischen Beobachtungen der letzten Jahre ein unerwartetes Resultat gebracht, das durch die verfeinerte Röntgentechnik (BERG, SCHATZKI, KNOTHE) und die spezielle Sektionstechnik (ANDERS und BAHRMANN) ermöglicht wurde: *Das allerfrüheste Stadium von Hiatusbrüchen* (»das bruchsacklose Stadium», »die epiphrenale Glockenbildung») *kommt bei älteren Individuen so häufig vor, dass es für dieses Alter beinahe als physiologisch betrachtet werden kann.*

So fand z. B. SCHATZKI bei Röntgenuntersuchung von 30 ohne besondere Wahl zur Untersuchung herangezogenen alten Individuen im Alter zwischen 65 und 83 Jahren in 14 Fällen bei liegender Stellung Teile des Magens über dem Zwerchfell. In weiteren 8 Fällen konnte eine solche Ausstülpung von Magenteilen oberhalb vom Zwerchfell durch abdominale Drucksteigerung (Lufteinblasung ins Kolon) hervorgerufen werden, insgesamt konnte sie also in 73.3 % der Fälle beobachtet werden. KNOTHE konnte an der Klinik v. Bergmanns in der Charité, Berlin, im Laufe eines Jahres fast 300 solche Fälle röntgenologisch nach-

weisen, meistens kleinere Dislokationen durch den Hiatus. ANDERS fand durch seine spezielle Sektionstechnik bei 24 von 32 (wahllos zur Untersuchung genommenen) Fällen im Alter von 60—90 Jahren, also bei 75 %, eine deutliche »epiphrenale Glockenbildung». Alle diese Beobachtungen sprechen übereinstimmend dafür, dass das *allererste Anfangsstadium eines Hiatusbruches bei älteren Individuen so ausserordentlich häufig vorliegt*, dass es fast als eine normale senile Veränderung bezeichnet werden kann.

Es könnte vielleicht jemandem umzutreffend erscheinen, eine solche fast physiologische Altersveränderung als allererstes Anfangsstadium eines pathologischen Prozesses zu bezeichnen. Ich für meinen Teil finde nicht, dass etwas Störendes in einer solchen Betrachtungsweise liegt, und es gibt ja eine Reihe von Gegenstücken hierfür auf anderen Gebieten (z. B. bei den senilen Haut- und Gefässveränderungen).

Die völlig entwickelten »erworbenen» Hiatusbrüche mit Bruchsack kommen natürlich viel weniger häufig vor als diese allerfrühesten Stadien, aber doch — wie ich schon in meiner ersten Arbeit hervorhob — bedeutend häufiger, als man es früher angenommen hatte. An meinem röntgenologischen Material sehe ich bei dem von mir gewöhnlich angewendeten Füllungsweg vom Magen aus fast jeden oder jeden zweiten Monat einen solchen Fall.

Dieselbe Auffassung über die Frequenz der *ausgebildeten Hiatushernien* geht beispielsweise aus MORRISONS (1928) Arbeit mit einer Kasuistik von 130 und der RITVOS (1930) mit einer Kasuistik von 60 röntgendiagnostizierten Fällen hervor). KOEPPEN und FRANK wiesen durch mikroskopische Schleimhautuntersuchung in 7 von 120 Sektionsfällen (also in 5—6 %) einen grösseren oder kleineren Teil des Magens oberhalb vom Hiatus nach, und in einem Falle eine besonders hochgradige »Hiatushernie im Sinne ÅKERLUNDS».

Unter ANDERS' 35 nicht ausgewählten Sektionsfällen im Alter über 50 Jahre, die mit der von ANDERS, speziell für in-situ-Untersuchungen der Hiatusregion ausgearbeiteten Sektionsmethode untersucht worden waren, fand sich in 4 Fällen, d. h. in 11 bis 12 %, ein *mit Bruchsack versehener Hiatusbruch*, also eine sehr gute Bestätigung für meine früher vorgebrachte Auffassung über die Frequenz der ausgesprochenen Hiatusbrüche. In zwei von den Fällen hatte sich nach der Auffassung von ANDERS auf Basis einer Hiatusinsuffizienz »sekundär» ein »echter Hiatusbruch» entwickelt, in zwei anderen Fällen gelang es, »durch stärkere Erhöhung des intraabdominalen Druckes infolge grösserer Mengen des injizierten Fixationsmittels bei vorhandener Hiatusinsuffizienz das Peritoneum fast 1 cm in den Hiatus vorzuwölben und so fixiert zu erhalten», also gerade der Entwicklungsgang, den ich hier oben auf Fig. 2 als den für erworbene Hiatusbrüche gewöhnlichen angab.

Die *Röntgensymptomatologie* der Hiatusbrüche ist nunmehr zu gut bekannt, als dass sie an dieser Stelle wiederholt zu werden brauchte, umsomehr als sich auf diesem Gebiete keine eigentlich neuen Gesichtspunkte ergeben haben.

Ich gehe vielmehr direkt auf die *röntgenologische Differentialdiagnostik* der Hiatusbrüche über und muss mich hier wieder etwas bei der obenerwähnten Arbeit von SAUERBRUCH, CHAOUL und ADAM aufhalten, die im September 1932 publiziert wurde und mich schon zu zwei eingehenden Entgegnungen veranlasst hat (D. M. W. 1932, Nr. 44 und 46).

Die Verfasser bestreiten ganz und gar die Existenz der erworbenen reponiblen Hiatusbrüche von dem Typus, den sie »die neue Form der Hiatushernien, wie sie von ÅKERLUND, BERG und KNOTHE beschrieben worden ist», nennen, d. h. vom Typ III meiner Gruppeneinteilung. Nach Ansicht der genannten Verfasser würde in diesem ganzen riesigen Material von hierher gehörenden Beobachtungen, die in den letzteren Jahren aus der ganzen Welt gesammelt wurden, nur eine röntgenologische Fehldeutung physiologischer Verhältnisse vorliegen. In der Mehrzahl der Fälle würden diese Hiatusbrüche nach den Verfassern durch ziemlich flüchtige, ampulläre Erweiterungen der epiphrenalen Ösophaguspartie *vorgetäuscht* sein, welche Dilatationen unter gewissen bestimmten mechanischen Untersuchungsbedingungen so gut wie bei *jedem Menschen jedes Alters* als eine Phase des Schlingaktes hervorgerufen werden können. In den übrigen, selteneren Fällen würden die hiatusbruchähnlichen Bilder durch *physiologische* Ausstülpungen der kardialen Magenpartie »innerhalb des Muskelkegels, der Zwerchfell und Ösophagus verbindet» zu erklären sein; diese Ausstülpungen würden also nur scheinbar oberhalb des Zwerchfells gelegen sein.

Es dürfte nicht vieler Worte bedürfen, um dieser Auffassung zu begegnen. Was zunächst die letztere Deutungsmöglichkeit betrifft, so dürfte es genügen, die obenerwähnten, gleich danach publizierten, äusserst genauen anatomischen Spezialuntersuchungen von ANDERS, NEUMANN, KOEPPEN und FRANK hervorzuheben, die ergaben, dass es überhaupt keine muskuläre Fixation des Ösophagus an das Zwerchfell gibt, noch weniger einen ausgebildeten Muskeltrichter, wie ihn die in Rede stehenden Verfasser voraussetzen. Als Entgegnung auf die erstere Behauptung der Verfasser, dass die grosse Mehrzahl der Hiatusbrüche aus fehlgedeuteten epiphrenalen Ösophagusdilatationen bestünde, mag es genügen zu erwähnen, dass gerade diese äusserst flüchtigen Ösophagusdilatationen den Röntgenologen seit vielen Jahren unter dem Namen von BARSONYS »Pseudohernien» (1928) wohl bekannt sind (vgl Seite 527), und dass eine solche Fehldeutung bei der hier oben geschilderten und empfohlenen Untersuchungstechnik niemals vorzukommen braucht. Die mechanischen Bedingungen, die diese momentanen Ösophagusdilata-

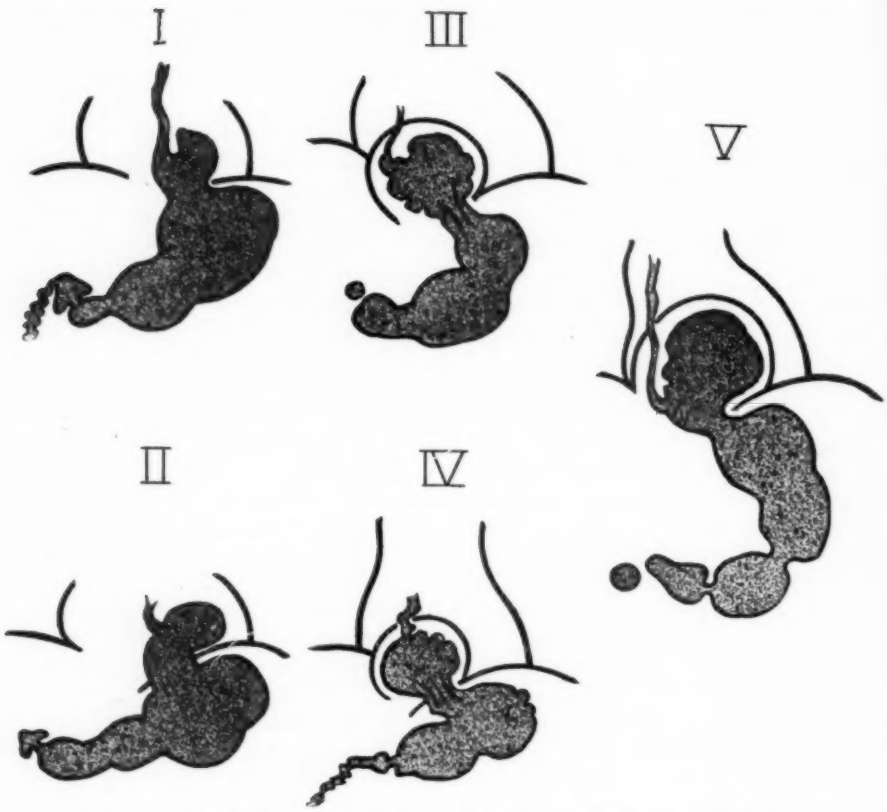

Fig. 3. Autoptisch verifizierte, echte Hiatusbrüche mit Bruchsack (Fall I—V).

tionen in Erscheinung treten lassen, sind nämlich von der üblichen Untersuchungstechnik für Hiatusbrüche so weit als nur irgend möglich verschieden.

Für die Diagnose *Hiatusbruch* fordert man ein rundliches, epiphrenales Kontrastdepot, das nach oben eine bestimmte, anatomisch präformierte Grenze von konstanter Lage hat (diese ist durch die Muskelmanschette der Cardia superior verursacht, die nach den Untersuchungen von ANDERS hypertrophiert, wenn die Cardia inferior insuffizient wird), das nach unten eine mehr oder weniger breite Kommunikation mit dem Magenschatten hat, das ferner bei ruhiger und unbehinderter Atmung praktisch genommen beliebig lange unter Durchleuchtung beobachtet werden kann, vorausgesetzt dass der Patient nicht die Lage ändert.

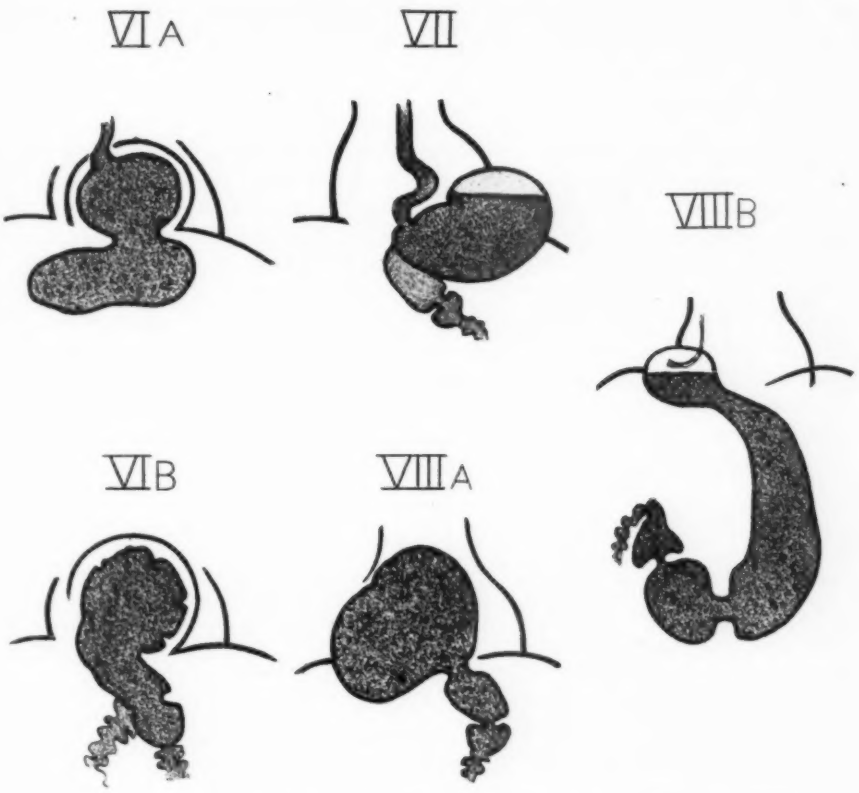

Fig. 4. Autoptisch verifizierte, echte Hiatusbrüche mit Bruchsack (Fall VI—VIII).

Eine »*Pseudohernie*» hat dagegen keine konstante obere Grenze und in der Regel keine breite Kommunikation nach unten, sie tritt nicht bei ruhiger Atmung auf, sondern setzt voraus, dass die Schlingpassage durch Atmungsstillstand in tiefer Inspirationsstellung verschlossen wird, was zu einer Hiatussperre führt; sie ist schliesslich von sehr flüchtigem Charakter und verschwindet nach höchstens einigen wenigen Atemzügen.

In meinem eigenen Material ist mir auch keine einzige solche Fehldeutung bekannt, die röntgenologische Diagnose »Hiatusbruch» wurde vielmehr in sämtlichen 8 Fällen, bei welchen eine autoptische Kontrolle bisher möglich war, vollauf bestätigt. Ich möchte nun als Abschluss einen kurzen Bericht über diese Autopsiefälle bringen, die durchwegs voll ausgebildete Hiatusbrüche betreffen.

Der Übersichtlichkeit halber sind nur Skizzen dieser 8 Fälle reproduziert, die in zwei Figuren nach der Grösse des Hiatusbruches angeordnet sind. Die römischen Ziffern geben die Nummer der Fälle in der Kasuistik an (Fig. 3 und 4).

Alle diese 8 röntgendiagnostizierten Fälle von Hiatusbruch wurden bei der anatomischen Untersuchung als echte Hiatusbrüche mit Bruchsack befunden; wenigstens 7 von den Fällen erwiesen sich als *reponibel* und gleichzeitig *nicht paraösophageal*, sie können also weder der Gruppe I noch der Gruppe II angehören, sondern sind offenbar Beispiele der Gruppe III, d. h. gerade des »erworbenen» reponiblen, nicht paraösophagealen Typus, dessen Existenz kürzlich von SAUERBRUCHS Klinik energisch bestritten wurde. Dem Röntgenbefunde nach zu urteilen, ist es äusserst wahrscheinlich, dass auch der restliche Fall (Fall 2) demselben »akquirierten» Typus angehörte, eine beschwerliche Narkose und bedeutender Fettansatz hinderten aber den Operateur daran, die für die Gruppenbestimmung notwendigen Beobachtungen zu machen; es konnte nur die Hiatusbruchdiagnose verifiziert werden.

Kasuistik

Fall I. (M. Kh. Df. h. 19.) 39jähriger Schwerarbeiter.

Röntgenbefund 30. VI. 1926. Bei Rückenlage (aber nicht in anderen Lagen) markierte sich ein pflaumengrosser, oberhalb vom Zwerchfell gelegener kontrastgefüllter Rezess, der nach unten am Platze des Hiatus breit mit dem übrigen Magenschatten zusammenhing, während der geschlängelte Ösophagus in den oberen Teil des Rezesses einmündete. *Röntgendiagnose:* Hiatusbruch (Fig. 3: I).

Operationsbefund: (Prof. KEY). 5. VII. 1926. Der oberste Teil des Magens durch den für 3 Finger durchlässigen Hiatus herniiert. Bei Hinunterziehung des Magens stülpte sich der Bruchsack um. Auch der Ösophagus konnte durch den Hiatus hinuntergezogen werden.

Fall II. (S. Kh. D. d. 16). 42jähriger Anstreicher.

Röntgenbefund 26. II. 1923. Bei liegender Stellung markierte sich ein apfelsinengrosser, epidiaphragmatischer Magenrezess, der am Hiatus breit mit der unter dem Zwerchfell gelegenen Magenportion zusammenhing. Die Einmündungsstelle des Ösophagus in den Magen markierte sich deutlich, hoch oberhalb des Zwerchfells, unmittelbar rechts vom oberen Pol des herniierten Magenrezesses. *Röntgendiagnose:* Hiatusbruch (Fig. 3: II).

Operationsbefund (Dr. RISSLER). 2. III. 1923. Viel subkutanes Fett und reichlich Fett im Omentum. Grosser und weiter Hiatus, in dem der obere Teil des hochliegenden Magens gelegen ist. Beschwerliche Narkose. Unmöglich, den Magen hinunterzuziehen und den Hiatus zu verengern.

Fall III. (M. Kh. Df. h. 17.) 38jährige Frau.

Röntgenbefund 27. V. 1926. Bei liegender Stellung trat ein mandarinengrosser epidiaphragmatischer Magenrezess hervor, der in einem ungefähr apfelsinengrossen, gleich-

mässigen runden Bruchsackschatten gelegen war. Das Verbindungsstück mit dem übrigen Magen war ungef. 3 Querfinger breit. Die Einmündungsstelle des Ösophagus markierte sich unmittelbar rechts vom oberen Pole des herniierten Magenrezesses, hoch oberhalb vom Hiatus. *Röntgendiagnose:* Hiatusbruch. (Fig. 3: III).

Operationsbefund (Prof. KEY) 21. VI. 1926. Der obere Teil des Magens durch den stark erweiterten, für eine Faust durchlässigen Hiatus herniiert. Ungefähr faustgrosser Bruchsack. Der Magen konnte leicht und vollständig hinuntergezogen werden.

Fall IV. (M. Kh. Df. h. 25). 55jähriger Marinekapitän.

Röntgenbefund: 12. I. 1927. In Bauchlage trat ein apfelsinengrosser Hiatusbruch mit breiter, der Lage des Hiatus entsprechender Bruchpforte hervor, in Rückenlage fand sich nur eine kleinere tütenförmige Ausfüllung, in stehender Stellung war keine sichere Veränderung in der Hiatusgegend nachweisbar. Die Einmündungsstelle des geschlängelten Ösophagus markierte sich an der höchsten Stelle des Hiatusbruches. *Röntgendiagnose:* Hiatusbruch (Fig. 3: IV).

Operationsbefund (Prof. KEY). 17. I. 1929. Der erweiterte Hiatus war für 4 Finger durchgängig. Der Zwerchfellbruch war relativ seicht und frei beweglich; keine Adhärenzen.

Fall V. (M. Kh. Df. h. 27 + R. K. Kh. Df. h. 4.). 44jähr. Frau.

Röntgenbefund 25. VIII. 1927. Ein (Fornix und oberen Teil des Corpus umfassender) Grapefrucht-grosser Hiatusbruch hinter dem Herzen füllte sich in liegender Stellung mit Kontrastmasse aus. In stehender Stellung markierte sich der Bruch durch die Fornixgasblase, war aber in dieser Stellung viel kleiner. Der Ösophagus verlief in einem Bogen hinter dem herniierten Magenteil und rechts von ihm; die Einmündungsstelle des Ösophagus in den oberen Sack markierte sich deutlich und lag oberhalb vom Hiatus, der wenigstens 2 Querfinger breit war. *Röntgendiagnose:* Hiatusbruch (Fig. 3: V).

Röntgenbefund 27. IV. 1928. Der Hiatusbruch unverändert.

Operationsbefund (Prof. SÖDERLUND) 11. V. 1928 bei transpleuraler Operation nach vorausgegangener Phrenicusexärese.

Der Hiatusbruch war unmittelbar links vom Ösophagus gelegen, die Bruchpforte gut für 2 Finger durchgängig. Der Bruch konnte vollständig reponiert werden. Der Ösophagus reichte gut aus und war bei der Reposition nicht hinderlich.

Fall VI. (F. Pr. D. d. 63 + M. Kh. Df. h. 45). 74jähr. Prof. emerit.

Röntgenbefund 28. V. 1921. In liegender Stellung markierte sich ein Hiatusbruch, der den Fornix und die obere Hälfte des Korpus enthielt. Der Ösophagus mündete in den intrathorakalen Magenrezess. *Röntgendiagnose:* Hiatusbruch (Fig. 4: VI A).

Operationsbefund (Dr. HYBBINETTE). 10. X. 1921. Bei der Operation (Resektion des Canalis ventriculi wegen eines Infiltrationsprozesses + G. E.) wurde ein Zwerchfellbruch konstatiert.

Röntgenbefund 28. XI. 1930. Die Untersuchung konnte nur bei liegender Stellung vorgenommen werden. Die Grösse des Hiatusbruches variierte in verschiedenen liegenden Stellungen zwischen der eines Hühnereis und der einer Faust, was auf eine wenigstens partielle Reposition deutete (Fig. 4: VI B).

Sektionsbefund (Dr. F. WAHLGREN) 4. XII. 1930. Der stark erweiterte Hiatus ist für 4 Finger durchgängig. Faustgrosser Bruchsack, der nach vorn und oben an das Perikardium grenzt. Die beiden oberen Drittel des Magens sind im Bruchsack gelegen. Kein Teil des Ösophagus in der Bauchhöhle oder der Bruchpforte.

Fall VII. (M. Kh. Df. h. 3.) 58-jähr. Major.

Röntgenbefund 28. IV. 1925. Der grössere Teil des Magens liegt über dem Zwerchfell hinter dem Herzen und links von der Mittellinie. Die Magenherniierung war in liegender und aufrechter Körperstellung gleich ausgesprochen. Der Ösophagus geschlängelt, seine Einmündungsstelle in den Magen markierte sich deutlich, weit oberhalb vom Hiatus. *Röntgendiagnose:* Hiatusbruch (Fig. 4: VII).

Operationsbefund (Prof. KEY) 6. V. 1925. Fornix und Corpus ventriculi durch den erweiterten Hiatus, aus welchem der Kanalis auftauchte, herniiert. Der ganze Magen und sogar das Ösophagusende konnten allmählich durch den Hiatus hinabgezogen werden; eine kleinere Adhärenz wurde gelöst. Der Hiatus liess leicht die Hand durch, die dann einen mehr als faustgrossen, peritonealbekleideten Bruchsack palpierte.

Fall VIII. (R. K. Kh. Df. h. 2 + M. Kh. Df. h. 30). 38jähriges Fräulein.

Röntgenbefund 6. II. 1928. Der grössere Teil des Magens (Fornix, Korpus, Sinus) in den Thorax herniiert, hauptsächlich rechts von der Mittellinie durch den Hiatus. Nur der Kanalis war in der Bauchhöhle gelegen. Der Grad der Herniierung war bei Untersuchung in Rückenlage, Bauchlage und stehender Stellung ungefähr gleich. *Röntgendiagnose:* Hiatusbruch (Fig. 4: VIII A).

Röntgenbefund 1. VI. 1928 (nach Abmagerungskur). Bei stehender Stellung war diesmal nur eine apfelgrosse, den Fornix enthaltende Magenportion herniiert. Der Ösophagus hatte einen geschlängelten S-förmigen Verlauf, und seine Einmündung in den Fornix war hoch oberhalb vom Hiatus deutlich wahrnehmbar (Fig. 4: VIII B). Bei Einnahme liegender Stellung und Beckenhochlage wurden ebenso wie früher das ganze Korpus und der Sinus herniiert.

Operationsbefund (Prof. KEY) 4. VI. 1928. Der herniierte Magen liess sich leicht hinunterziehen. Keine Adhärenzen zwischen Magen und Bruchsack. Der Ösophagus war ausreichend, um durch den Hiatus hinuntergezogen werden zu können.

ZUSAMMENFASSUNG

1. Verf. konstatiert, dass sowohl der von ihm in früheren Arbeiten vorgeschlagene *Name* »Hiatusbrüche» als auch deren *Gruppeneinteilung* im allgemeinen in der Röntgenliteratur angenommen worden ist. (Gruppe I: Kongenitale Verkürzung des Ösophagus, Gruppe II: paraösophageale Brüche im eigentlichen Sinne, Gruppe III: Die Pars abdominalis oesophagi ist an der Herniierung beteiligt; die Brüche dieser Gruppe werden nunmehr als akquiriert betrachtet.)

2. Bei der Röntgenuntersuchung kommen *zwei Wege zur Kontrastfüllung eines Hiatusbruches* in Frage a) von unten, zunächst vom Magen, eine gröbere und einfachere Methode, die jedoch für die ausgesprocheneren, klinisch wichtigeren Fälle ausreichend ist, b) von oben, direkt vom Ösophagus, eine subtilere Methode, die bei genügender Erfahrung auch den Nachweis der ersten Anfangsstadien der erworbenen Hiatusbrüche gestattet, deren klinische Bedeutung indes sehr diskutabel ist.

3. Was die vom Verf. referierte *normale Anatomie des Hiatusgebietes*, und zwar zunächst das Verhalten des Peritoneums betrifft, kann man sagen, dass das Hiatusbruchgebiet selbst extraperitoneal liegt. Verf. referiert ferner die anatomischen Untersuchungen des letzten Jahres über die Hiatusmuskulatur, die normale Verschiebbarkeit des Ösophagus und die normale Lage der anatomischen Kardia (KOEPPEN und FRANK, ANDERS, NEUMANN), welche Untersuchungen die Unhaltbarkeit des von SAUERBRUCH, CHAOUL und ADAM in diesen Fragen eingenommenen Standpunkt zeigen.

4. Verf. gibt eine auf die anatomischen Untersuchungen gegründete Darstellung des *Entstehungsmechanismus und des Entwicklungsmodus der erworbenen Hiatusbrüche.* Unter Einwirkung mannigfaltiger, näher angegebener Momente beginnen sich erst das Antrum cardiacum und sodann angrenzende Magenpartien durch den Hiatus nach oben auszustülpen. Die Organwanderung tritt in ihrem allerersten Stadium unter dem *Typus eines bruchsacklosen Bruches* auf; erst wenn die Herniierung eine gewisse Grösse erreicht hat, wird auch das Peritoneum ausgestülpt. Dass die Peritonealbekleidung anfangs fehlt, ist nach Ansicht des Verfassers kein Grund dafür, die Hiatusausstülpungen anders als Hiatusbrüche oder — wenn man will — »kleine bruchsacklose Hiatusbrüche» zu nennen. (Vgl. ANDERS: »Hiatusinsuffizienz mit epiphrenaler Glockenbildung» oder »thorakale Dystopie des Antrum cardiacum» und NEUMANN: »Bulbusbildung», »Bulbus antri cardiaci»).

5. Sowohl Röntgenuntersuchungen als auch spezialanatomische in-situ-Untersuchungen haben gezeigt, dass bei älteren Individuen *kleine bruchsacklose Organausstülpungen durch den Hiatus oesophageus* — also die allerersten Anfangsstadien der erworbenen Hiatusbrüche — so häufig vorkommen, dass sie beinahe als *physiologische Altersveränderungen* bezeichnet werden können. Die ausgesprochenen Hiatusbrüche mit Bruchsack sind natürlich viel seltener, aber — nach übereinstimmenden röntgenologischen und pathol.-anat. Erfahrungen — bedeutend häufiger, als man früher angenommen hat.

6. Im Zusammenhang mit der *röntgenologischen Differentialdiagnostik der Hiatusbrüche* wird SAUERBRUCH, CHAOUL und ADAMS kategorische Bestreitung der Existenz der erworbenen Hiatusbrüche zurückgewiesen. Daran schliesst sich eine Entgegnung auf den Versuch der genannten Verfasser, publizierte Röntgenbilder von erworbenen Hiatusbrüchen als röntgenologische Fehldeutungen zu bezeichnen.

7. Verf. teilt sein bisheriges autoptisches Material (8 Fälle) von röntgendiagnostizierten Hiatusbrüchen mit. Alle diese 8 Fälle erwiesen sich bei der anatomischen Untersuchung als wirkliche Hiatusbrüche mit Bruchsack. Wenigstens 7 von diesen Fällen (wahrscheinlich alle) gehören, wie sich zeigte, der Gruppe III an, also *gerade* dem bestrittenen, reponiblen, »erworbenen», nicht paraösophagealen Typus.

SUMMARY

1) The author states that both *the name* (oesophageal) »hiatus hernia», suggested by him in previous papers, and *the subdivision of these hernias* have been largely adopted in röntgenological literature: (Group I: congenital shortening of the oesophagus, Group II: para-oesophageal hernia in the real sense, Group III: abdominal portion of oesophagus participating in the hernia, this group beeing nowadays considered »acquired»).

2) For the purpose of röntgen examination there are *two ways in which the contrast material may fill the hiatus hernia*, a) from below, proximately from the stomach, a coarser and simpler method, which is, however, sufficient for the more marked clinically important cases, b) from above, directly from the oesophagus, a more subtile method, which with sufficient experience allows the demonstration of the very beginning stages of acquired hiatus hernia, the clinical significance of which is, however, very much open to discussion.

3) With regard to *the normal anatomy of the oesophageal hiatus* the author first mentions the peritoneal relations. The hiatus area itself may be said to lie extra-peritoneally. The author further refers to the anatomical investigations of the last year in regard to the hiatus musculature, the normal movability of the oesophagus and the normal situation

of the anatomical cardia which have been carried out by KOEPPEN and FRANK, ANDERS and NEUMANN, whose work shows the untenability of the standpoint of SAUERBRUCH, CHAOUL and ADAM on these questions.

4) The author gives a presentation of the *mechanism of origin and subsequent development of the acquired hiatus hernia* based on the above mentioned anatomical investigations. Under the influence of manifold different causes, described in detail there begins a visceral protrusion up through the hiatus. The abdominal portion of the oesophagus passes through first and then the adjacent portions of the stomach follow. This visceral protrusion in its very first stages assumes the character of an *hernia without a hernial sack* and only when the hernia has reached a certain size is there also a bulging of the peritoneum. The fact that there is in the beginning no peritoneal covering is according to the author no reason for naming the beginning visceral dislocation anything else than »hiatus hernia», or if one wishes, »small sackless hiatus hernia» (cf. ANDERS: »Hiatus insufficiency with formation of a bell-shaped epiphrenic cardiac recess» or »thoracic dystopia of the cardiac antrum» and NEUMANN: »Bulbformation», »Bulbus antri cardiaci»).

5) Röntgen examinations as well as special anatomical investigations made in situ in old individuals have shown that *small sackless visceral protrusions through the oesophageal hiatus* — thus the very beginning stages of acquired hiatus hernia — are so common in this material that they *can almost be called physiological changes of age*. Pronounced cases of acquired hiatus hernia with a hernial sack are naturally very much rarer but — according to agreeing röntgenological and pathological anatomical experience — considerably more common than has been believed.

6) With regard to the *röntgen diagnosis* of hiatus hernia SAUERBRUCH, CHAOUL and ADAM's categorical denial of the existence of acquired reducible hiatus hernia is rejected. The attempts of these authors to label as röntgenological misinterpretations the published röntgen pictures of acquired hiatus hernia are replied to.

7) The author gives a report of his autopsy material so far obtained of röntgenologically diagnosed hiatus hernia (8 cases). On anatomical examination all 8 were found to be real hiatus hernia with a hernial sack. At least 7 and probably all of these cases belonged to Group III that is to the acquired reducible type denied by SAUERBRUCH, CHAOUL and ADAM and not to the para-oesophageal type.

RÉSUMÉ

1) L'auteur constate que la littérature radiologique a adopté à la fois la *dénomination* de »hernie de l'hiatus» et la *classification* par groupes qu'il a proposées dans des travaux antérieurs. (groupe I: raccourcissement congénital de l'œsophage; groupe II: hernies para-œsophagiennes proprement dites; groupe III: la portion abdominale de l'œsophage est comprise dans la hernie; considérée actuellement comme hernies »acquises»).

2) Dans l'examen radiologique, *deux voies* peuvent être utilisées *pour la réplétion de contraste d'une hernie de l'hiatus:* a) la voie inférieure, de l'estomac, méthode grossière et simple, qui est cependant suffisante pour les cas plus prononcés et cliniquement importants; b) la voie supérieure directe, de l'œsophage, méthode plus délicate, mais qui pour un opérateur suffisamment expérimenté, permet de déceler les premiers stades initiaux des hernies acquises de l'hiatus, stades dont l'intérêt clinique est cependant très discutable.

3) En ce qui concerne *l'anatomie normale de la région de l'hiatus*, l'auteur aborde d'abord la question du péritoine: la région proprement dite des hernies de l'hiatus peut

être dite extrapéritonéale. L'auteur rend également compte des recherches anatomiques faites au cours des dernières années par KOEPPEN et FRANK, ANDERS, NEUMANN, sur la musculature de l'hiatus, sur la mobilité normale de l'œsophage et sur la position normale du cardia anatomique, recherches qui démontrent l'impossibilité d'accepter le point de vue adopté dans ces questions par SAUERBRUCH, CHAOUL et ADAM.

4) L'auteur expose, en se basant sur les recherches anatomiques, *le mécanisme de la production et la marche évolutive des hernies acquises de l'hiatus*. Sous l'influence d'un grand nombre de facteurs plus spécialement indiqués, il se produit *un déversement des viscères dans l'hiatus*, d'abord de l'antrum cardiacum et, ultérieurement, des parties avoisinantes de l'estomac. Cette migration des viscères apparaît, *dans son tout premier stade*, sous la forme *d'une hernie sans sac herniaire;* c'est seulement au moment où la hernie a atteint un certain volume que se produit également le déversement du péritoine. Le fait que le revêtement péritonéal fait défaut au début, ne constitue point, au sens de l'auteur, une raison pour donner à cette invasion de l'hiatus un autre nom que celui de hernie de l'hiatus, ou, si on veut »de petite hernie de l'hiatus sans sac». (cf. ANDERS: »Insuffisance de l'hiatus et formation de cloche épiphrénique» ou »dystopie thoracique de l'antrum cardiacum», et NEUMANN: »Formation de bulbe», »Bulbus antri cardiaci»).

5) Les examens radiologiques aussi bien que les recherches anatomiques spéciales in situ ont montré que, chez les personnes âgées, *les petits déversements des viscères sans sac herniaire à travers l'hiatus œsophagien* — c. à. d. le tout premier stade de la hernie acquis de l'hiatus — constituent un phénomène si fréquent qu'on pourrait presque les considérer comme *des altérations physiologiques séniles*. Les hernies plus prononcées de l'hiatus, avec sac herniaire, sont évidemment beaucoup plus rares mais — à en juger par les indications concordantes de la radiologie et de l'anatomo-pathologie — sensiblement plus fréquentes qu'on ne le supposait antérieurement.

6) A propos du *diagnostic différentiel radiologique* des hernies de l'hiatus, l'auteur s'élève contre les affirmations de SAUERBRUCH, de CHAOUL et d'ADAM, qui nient l'existence des hernies acquises de l'hiatus. Les tentatives de ces auteurs pour représenter les radiographies publiées de hernies acquises de l'hiatus comme de fausses interprétations sont réfutées par l'auteur.

7) L'auteur communique le matériel biopsique et nécropsique qu'il a réuni jusqu'ici de hernies de l'hiatus diagnostiquées radiologiquement (8 cas). A l'examen anatomique, tous ces huit cas se montrèrent être de véritables hernies de l'hiatus, avec sac herniaire et 7 au moins de ces cas (et probablement tous les 8) rentraient dans le groupe III et appartenaient donc *justement* à ce type réductible, acquis, non para-œsophagien, qui a été nié.

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UNE SOURCE D'ERREURS NÉGLIGÉE DANS L'INTERPRÉTATION DES PYÉLOGRAPHIES[1]

par

S. Ribbing, Med. lic.

(Tabulæ LXX—LXXIII)

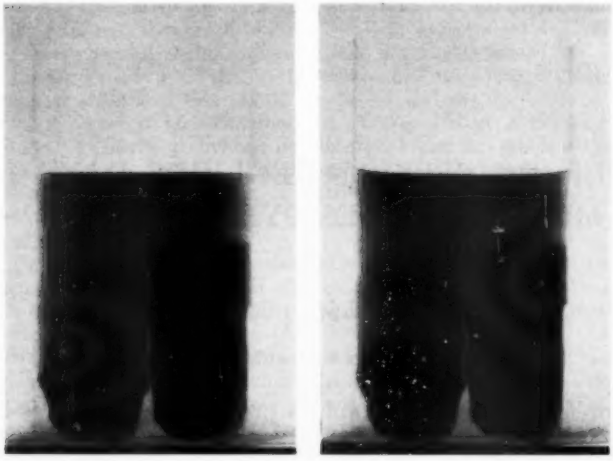
L'interprétation des pyélographies présente bien des fois de grandes difficultés. La cause essentielle de ceci est que l'aspect du bassinet normal varie beaucoup d'un cas à l'autre et à un certain degré même d'un moment à l'autre. De plus on ne peut pas par les images ordinaires du bassinet se faire une impression de la troisième dimension. C'est par la pyéloscopie et par la stéréoradiographie ou la radiographie dans plusieurs directions qu'on a essayé de surmonter ces difficultés.

Quelles sont les observations essentielles qu'on fait sur une image pyélographique du bassinet rénal? — Outre sa situation vis-à-vis des organes entourants c'est surtout sa grandeur, sa forme et la netteté de ses contours. Dans ce qui suit je vais indiquer une source d'erreurs dans l'interprétation des images qu'on obtient par la pyélographie rétrograde. Cette source d'erreurs peut dans certaines conditions influer sur toutes les qualités nommées ci-dessus; mais il paraît qu'on l'a mal comprise et qu'elle a été peu considérée dans la littérature et probablement aussi dans la pratique.

On trouve que même après l'introduction d'une sonde urétérale dans le bassinet rénal il y reste souvent une certaine quantité d'urine. Quelques auteurs recommendent l'aspiration de cette urine par une seringue avant l'injection du liquide opaque. S'il y a de l'urine dans le bassinet quand le contraste est injecté, il arrive que les deux liquides ne se mélangent pas instantanément et avec facilité, ce qu'on semble présumer dans la plupart des publications dans ce domaine. Je parle ici des solutions aqueuses des sels simples ou des sels composés halogènes; ceux-ci s'emploient habituellement pour la pyélographie.

Le fait que les liquides opaques lourds descendent au fond du bassinet et que l'urine se dispose par couches au-dessus — ainsi que l'importance

[1] Reçu par la rédaction le 9. IX. 1933.



a. *b.*

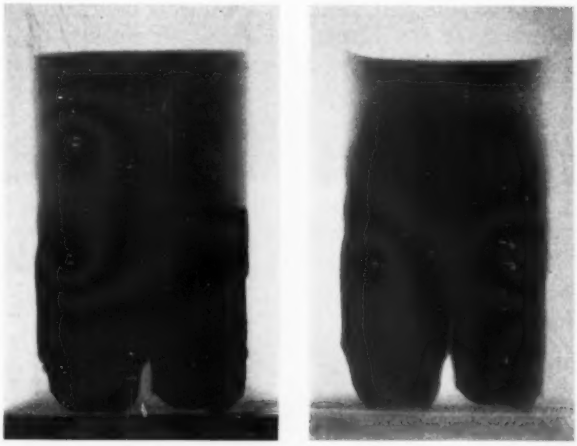
Figure 1 (d'après LAURELL):

Une coupe de papier paraffiné, dont la partie inférieure a été divisée en deux sections par une cloison de la même matière, est remplie d'urine jusque par-dessus la cloison. Dans la partie droite de la coupe on verse par une sonde fine une solution de collargol à 5 % si abondemment qu'elle dépasse la cloison.

a. Immédiatement après le remplissage. Le collargol et l'urine ne se sont pas mélangés, mais montrent dans la partie droite de la coupe une limite nette; dans la partie gauche, où le collargol a coulé par une couche d'urine épaisse, il descend au fond et montre une limite supérieure inexacte.

b. Après 12 heures.

de ce fait — a été signalé par LAURELL dans une conférence à Stockholm en 1923 à une séance de la »Nordisk Förening för Medicinsk Radiologi». Ce qui amena LAURELL à l'observation de la tendence de stratification des liquides opaques fut un cas, où l'image pyélographique était composé seulement de quelques calices élargis, et où le pôle rénal inférieur était disloqué latéralement par une tumeur à contour inférieur rond, disposé médialement de ce pôle. Que cette tumeur fut le bassinet extra-rénal fortement agrandi fut une surprise au courant de l'opération. Pendant la pyélographie le liquide opaque avait été stratifié dans les calices situés le plus bas, et le bassinet extra-rénal n'avait pas donné d'ombre dense sur le film. LAURELL montra ensuite par des expériences *in vitro* comment des solutions de contraste de différentes sortes, comme le collargol, le bromure de soude, le iodure de potasse, etc. ont une grande tendence à descendre au fond d'une coupe pleine d'urine, et que ce n'est qu'après bien des heures qu'elles se mélangent avec l'urine, si on ne remue pas la coupe. Le procédé ressemble au phénomène qu'on observe, quand on fait



a. *b.*

Figure 2 (d'après LAURELL):

La même expérience que dans la figure 1, mais avec une solution de bromure de soude à 25 %

a. Immédiatement après le remplissage du liquide opaque.
b. Après 24 heures les liquides ont été mélangés insuffisamment.

couler une solution épaisse de sucre dans de l'eau. D'une série de clichés pas encore publiés, par lesquels LAURELL a illustré sa conférence, j'ai eu l'occasion de publier les figures 1 et 2.

Il a plus tard été noté incidemment par quelques auteurs que les pyélographies sont quelquefois difficiles à interpréter à cause du mélange insuffisant du liquide opaque avec l'urine. VOELCKER, un des pionniers de la pyélographie, a remarqué en 1929: »Nicht immer gelingt die Pyelographie von grossen Sacknieren gut, meistens deshalb nicht, weil es schwer ist, vor Einspritzung der Kontrastflüssigkeit den Nierensack durch den Ureterkatheter genügend zu entleeren. Enthält er noch reichlich Urin, und spritzt man das Umbrenal in den halb gefüllten Sack ein, so können selbstverständlich keine klaren Umrisse zustande kommen. Manchmal sieht man dann das Kontrastmittel, das sich mit dem Urin nicht genügend gemischt hat, in unregelmässigen Klecksen auf der Platte erscheinen.»

MACALPINE s'exprime en 1929 dans le même sens au sujet d'une image que je reproduis de son ouvrage (fig. 3): »On the left side there is a very large hydronephrosis, the lower limit of which is identified by a transverse trickle of fluid opposite the bottom of the third lumbar vertebra. The rest of the solution has gravitated to the sump of the hydronephrosis where it has formed a pool. The size of the sac can be surmised.»

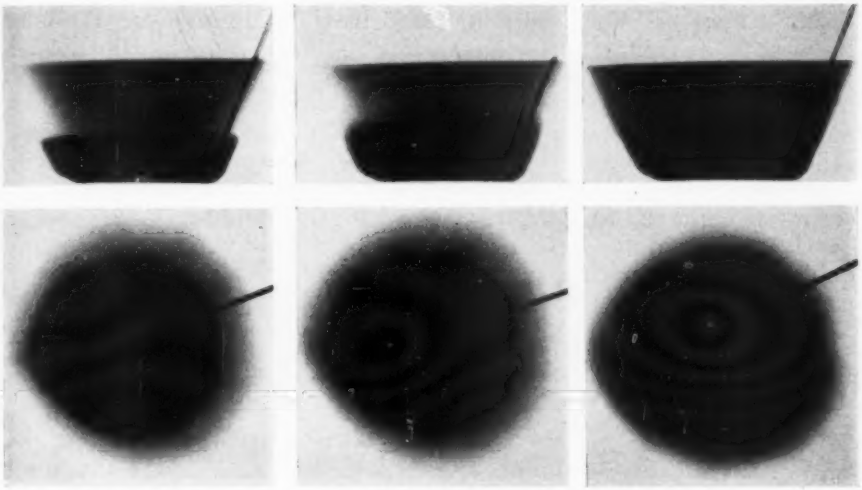
Ni la constatation de LAURELL, ni les observations des deux auteurs cités ne semblent avoir été dûment observés, et puisque la connaissance de la tendence des liquides opaques à descendre au fond dans l'urine peut avoir une grande importance pour l'interprétation des pyélographies, je juge motivée une discussion plus détaillée de ce sujet.

Figure 3 (d'après MACALPINE). Voir le texte.

Le liquide opaque, dont on s'est servi pendant ces dernières années pour la pyélographie rétrograde à l'Institut Radiologique d'Upsala est l'abrodil dans une solution à 20 %. J'ai répété avec ce liquide l'expérimentation *in vitro* de LAURELL. Le liquide opaque a coulé par une sonde urétérale dans une coupe d'urine. Comme le montre la figure 4, le liquide opaque s'assemble d'abord au fond et ensuite, dans le cours de plusieurs heures, il se mélange avec l'urine. La figure 5 montre que le procédé peut être analogue, quand le liquide opaque est injecté dans un bassinet rénal. Ce film du bassinet gauche est pris dans une direction horizontale des rayons après une injection de 3 cc. de solution d'abrodil pendant que le malade était couché sur le côté gauche. Il est à noter dans ce cas que la sonde urétérale n'atteignit pas le bassinet. Le liquide opaque a coulé comme le montre la figure, dans un mince courant par le bassinet rempli d'urine et a formé une couche de fond avec un niveau supérieur horizontal. C'est justement ce niveau qui nous montre que le bassinet contenait aussi de l'urine.

Si la stratification d'urine et de liquide opaque, qui a été décrite ici, apparaît, et si le bassinet est radiographié dans la direction verticale des rayons, on peut se méprendre sur la grandeur du bassinet, parce qu'on ne voit sur le film que la partie qui est remplie du liquide opaque (voir la figure 6). Cela devient souvent le cas, si la pointe de la sonde est posée dans un calice dilaté. La netteté du contour peut aussi diminuer ou disparaître à cause de la couche de contact diffuse entre le liquide opaque concentré et l'urine (voir la figure 7). Et, finalement, des changements de forme et des images claires, des défauts d'opacification peuvent être causés par le fait que des parties du bassinet ne sont remplies que d'une urine qui n'est pas mélangée avec le liquide opaque (voir les figures 8, 9 et 10).

Dans les exposés du diagnostic radiologique des affections rénales qui ont été donnés par JOSEPH et par BOEMINGHAUS et ZEISS, on cherche en vain des constatations de l'importance de la stratification en pyélogra-



a. *b.* *c.*

Figure 4.

Dans une coupe d'urine une solution d'abrodil à 20 % a coulé par une sonde fine.

a. Immédiatement après le remplissage.
b. Après 2 heures.
c. Après 14 heures.

Les clichés dans la rangée supérieure sont radiographiés avec une direction horizontale des rayons, ceux de la rangée inférieure avec une direction verticale des rayons. Les clichés montrent comment le mélange insuffisant peut influencer en apparence la grandeur aussi bien que la netteté du contour d'un espace rempli de liquide opaque.

phie, et cela malgré que les auteurs publient des clichés qui montrent que le liquide opaque est descendu au fond d'un bassinet rempli d'urine.

Swan indique que s'il s'attend à un bassinet de grandeur normale, il se sert pour la pyélographie d'une solution de bromure de soude à 12 %, mais s'il soupçonne une hydronéphrose, il emploie une solution à 30% du même sel, parce qu'autrement la solution devient trop diluée par l'urine stagnante dans le bassinet. Il présume probablement qu'un mélange se fait facilement. On doit évidemment compter avec une tendence à descendre au fond encore plus forte chez la solution opaque de haut titre.

Bien des auteurs se sont rendus coupables d'interprétations plus ou moins inexactes de ces images qu'on obtient pas la descente au fond du bassinet du liquide opaque. On trouve par exemple, dans la littérature, des constatations suivant lesquelles certains films indiqueraient que le bassinet est contracté (Mühsam, Gloor, Eisendraht). Beaucoup de ces images pourraient plutôt être interprétés par le fait que ces parties du bassinet ont été remplies d'urine qui n'était pas mélangée avec le liquide

opaque. Concernant les contractions du bassinet MOTZ écrit: »Pendant sa période de contraction le bassinet présente des irrégularités tant au point de vue de la coloration qu'au point de vue de contour. Au cours des mouvements de brassage du liquide opaque on peut trouver des images où le bassinet presque vidé de son contenu apparaît clair tandis que les calices sont foncés.» Certainement M. parle justement de ces images qui proviennent du mélange *insuffisant* de l'urine avec le liquide opaque (voir les figures 9, 10, 11 a, 12 b, 14 a.)

Dans une critique de l'usage du lipiodol pour la pyélographie, parce qu'il ne peut pas se mélanger avec l'urine, MAINGOT touche cette question, mais il exagère la capacité des solutions aqueuses de se mélanger avec l'urine. Il dit: »A mon sense, les pyélographies soit avec les suspensions opaques comme le collargol, soit avec des solutions aqueuses comme les bromures et les iodures sont beaucoup plus fidèles: Elles se mélangent au contenu liquide du bassinet et moulent exactement les contoures de celui-ci.» NEUSWANGER a formulé une opinion analogue et BLANC a noté que la présence d'urine dans le bassinet »donnera à côté du lipiodol des images lacunaires dont l'interprétation deviendra impossible», ce qui ne serait pas le fait dans les pyélographies avec les solutions aqueuses.

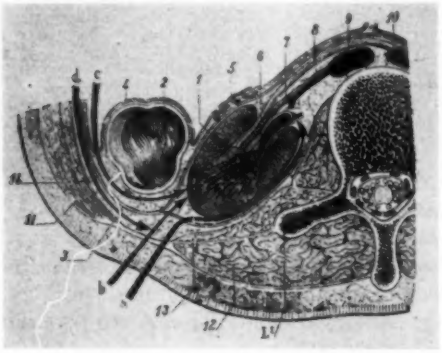


Figure 15 (d'après TESTUT et JACOB).

Le pédicule du rein et les différentes voies d'accès sur le bassinet et le rein, vus sur une coupe horizontale de la région lombaire gauche (demi-schématique).

PFLAUMER a publié un cas d'hydronéphrose commençante causée par une bride vasculaire derrière le bassinet à la limite de l'uretère. La pyélographie montre en cet endroit une image claire, selon P. causée par la presse de la bride. Le cliché reproduit se laisse plutôt interpréter autrement: la partie claire du bassinet est située le plus ventralement, et dans le décubitus dorsal cette partie est remplie d'une urine qui n'est pas mélangée avec le liquide opaque. D'une manière analogue FEY n'a probablement pas bien interprété certaines de ces images. Le psoas est en décubitus dorsal un seuil pour le système liquide dans le bassinet et la partie proximale de l'uretère. C'est donc l'issue du bassinet qui devient insuffisamment ou pas du tout rempli de liquide opaque dans les pyélographies en décubitus dorsal (voir les figures 11 a, 12 a, 13 a, 15).

MATTES fait valoir que si on injecte dans le bassinet quelques cc. de plus de liquide opaque que le bassinet déjà rempli ne contient auparavant, l'ombre du bassinet ne grandit pas, mais devient plus dense. L'explication très simple: que l'urine qui avait été poussée dessus par le liquide opaque a alors été forcé de sortir par l'uretère et a été remplacé par le liquide injecté dernièrement, n'est pourtant pas donnée par M.

Un détail essentiel pour la pratique est aussi qu'un défaut d'opacification apparent, occasionné par de l'urine qui n'est pas mélangée avec le liquide opaque peut être interprété comme causé par un calcul. Peut-être BEER a-t-il commis une telle erreur. LAUBER fait valoir que dans bien des cas le bassinet ampullaire est causé par un obstacle d'évacuation à cause d'un calcul sur la limite entre le bassinet et l'uretère. L. appuie cette opinion sur des films montrant des images claires en ce lieu. Mais ces images viennent selon mon opinion plutôt de la présence en cet endroit d'une urine qui n'est pas mélangée avec le liquide opaque.

BOEMINGHAUS a publié un cas, où un grand défaut d'opacification était présumé dépendre d'une masse calculeuse. L'opération montra que le bassinet n'en contenait pas. B. n'essaye pas d'expliquer ce défaut d'opacification sur son film. Mais on peut soupçonner, dans ce cas aussi, qu'il correspond à une urine qui n'est pas mélangée avec le liquide opaque. La figure 5 présente ici un certain intérêt. A l'injection, une petite bulle d'air était involontairement entrée par la sonde. Une fois entrée, cette bulle d'air va dans toutes les positions se mettre au point le plus haut du bassinet. La figure 5 b, où elle est placée dans la partie proximale de l'uretère, montre comment elle peut facilement être prise pour un calcul, transparent aux rayons X. Sur un film qui a été pris avec le sujet placé en décubitus ventral on n'a pas retrouvé de défaut d'opacification en ce lieu. — Volontairement deux auteurs (GARRY et DRUCKMANN) ont pour le diagnostic rempli le bassinet simultanément d'air et de liquide opaque. Je ne me suis servi de cette méthode qu'incidemment et involontairement (voir le figure 12 c). La méthode donne, comme le montre la figure, en même temps une image des parties inférieures et supérieures du bassinet. Il existe cependant même ici une source d'erreurs dans la formation d'une couche intermédière d'urine qui ne donne ni une ombre positive, ni une ombre négative.

MÜHSAM a démontré que les différentes parties du bassinet se remplissent successivement pendant l'injection du liquide opaque, mais il n'en explique pas les causes. La quantité de liquide opaque injectée tout d'abord se place au fond des parties les plus basses du bassinet. Quand l'injection continue, le niveau supérieur du liquide opaque monte peu à peu jusqu'au moment où il atteint le haut de la paroi qui le sépare de la partie voisine du bassinet. Au fond de celle-ci s'assemble la quantité de liquide opaque injectée ensuite. Ce fait est illustré par les figures 1, 8 et 14a.

HRYNTSCHAK écrit à propos de ses observations de pyéloscopie: »It is exceedingly interesting to observe the filling process; sometimes the shadow of the entire renal pelvis and the calyces slowly becomes deeper and clearer until, at last, it shows a sharp and distinct picture on the screen. In most instances, however, one calyx after the other fills and then suddenly appears before the eyes, seemingly from nowhere.» H. a ici certainement décrit les différents modes de remplissage du bassinet dans les deux cas, d'une part quand il est presque vide, d'autre part quand il contient de l'urine stagnante au commencement de l'injection. Il ne note cependant pas que ceci est la cause du mode différent de remplissage.

GLOOR, NEUSWANGER, NICHOLS, ZIEGLER attirent l'attention au danger de mal interpréter les films quand le bassinet n'est pas complètement rempli. WESSON dit qu'on peut alors obtenir des formations ressemblant à des tumeurs. Certainement le bassinet est plein de liquide dans ces cas, mais ces auteurs n'ont évidemment pas fait la réflexion que c'est seulement une partie du liquide remplissant qui donne de l'ombre. BRAASCH et HAGER parlent aussi des images artificielles à cause du remplissage insuffisant du bassinet et d'erreurs à cause de la dilution du liquide opaque avec l'urine.

GLOOR démontre comme caractéristique pour les pyonéphroses que les calices dilatés ont une limite inexacte. La cause en est selon G. que les parois sont couvertes de masses de détritus et de membranes de genèse inflammatoire. La limite inexacte peut cependant, comme je l'ai déjà noté et comme on voit sur plusieurs de mes images, apparaître à cause de la couche de contact entre le liquide opaque et l'urine. Cette indice ne donne donc pas de point d'appui dans le dignostic différentiel entre une hydronéphrose et une pyonéphrose.

Quelques auteurs recommendent la pyélographie en position redressée comme une exploration complétante de valeur (BOWMAN et GOIN, LEARMONT, SCHAW etc.). Quand celle-ci est pratiquée on trouve souvent que l'image d'un bassinet qui avait l'air à peu près normale quand le sujet était couché, change d'aspect quand il passe à une position redressée. Sa limite supérieure consistera alors d'un niveau horizontal, ce qui fait que le bassinet semble coupé. Mais ces auteurs non plus ne notent la tendence du liquide opaque de descendre au fond du bassinet rempli d'urine.

HUTTER a d'une manière frappante mal interprété les images qui apparaissent à cause de la stratification du liquide opaque sous l'urine. Dans des cas de bassinet élargi il a trouvé que la limite médiale de la pyélographie s'étend quelquefois au long du bord latéral du psoas. H. en tire la conclusion que le bassinet constitue ici un sac détendu dont la forme dépend des organes entourants et qui se tient spécialement en rapport avec le psoas. La vérité est, (voir la figure 15), comme j'ai déjà dit, que le psoas forme une sorte de seuil au-dessus duquel l'évacuation du bassi-

net dans l'uretère doit passer. Si le malade est placé en décubitus dorsal et si la quantité du liquide opaque a été dimensionnée de telle sorte que son niveau supérieur horizontal est à la hauteur de la surface latérale du psoas, on comprend facilement que si les rayons sont dirigés verticalement, la limite médiale de l'ombre dense est projetée le long du bord latéral du psoas. Mais il n'est pas juste d'en tirer la conclusion, comme le fait HUTTER, que le bassinet lui-même a cette forme et qu'il est un sac détendu qui ne peut pas renfermer son contenu, comme on voit de la figure 12. Sur le film pris en décubitus dorsal on ne voit pas l'issue en forme de cône du bassinet dans l'uretère, parce que cette issue est remplie d'urine. Le procédé très simple de radiographier le malade aussi en décubitus ventral montre que le »Psoasrandsymtom» de HUTTER est sans importance. HUTTER n'interprète pas très exactement ses images aussi dans un autre sens, que nous avons déjà traité. Quand les calices se montrent plus minces à la pyélographie rétrograde qu'à la pyélographie par injection intra veineuse, cela ne dépend pas d'un état de contraction spastique, mais du fait que le liquide opaque injecté par la sonde se place seulement comme une mince couche au fond des calices. La comparaison entre les images de la pyélographie rétrograde et par injection intraveineuse du même bassinet aurait bien pu attirer l'attention de H. sur les images artificielles qui apparaissent à cause de la descente au fond du bassinet du liquide opaque. Il est vrai que juste au commencement de l'aflux de l'urine opaque au bassinet pendant la pyélographie par injection intraveineuse on peut remarquer une certaine inégalité dans le remplissage, mais sur le plus haut point de l'aflux, l'urine qui ne contient pas de contraste a presque complètement quitté le bassinet. Celui-ci a alors été rempli d'urine opaque, qui a accoulé par une quantité de canaux fins dans les parois du bassinet, ce qui doit aussi favoriser un mélange homogène. Aussi la tendance de stratification n'est pas du tout aussi grande que dans la pyélographie rétrograde, ce qu'on constate par une expérience *in vitro* du même genre que les autres nommées ci-dessus: On a laissé une urine recueillie après une pyélographie intraveineuse couler par une sonde dans une urine ordinaire. Une stratification au fond de l'urine opaque n'a pas pu se constater (fig. 16).

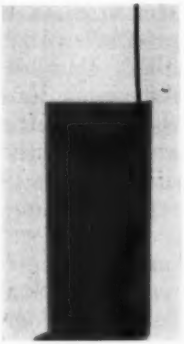


Figure 16.
Voir le texte.

La manière la plus simple d'explorer les conditions anatomiques du bassinet, en ce qu'ils ne se montrent pas clairement par la stratification du liquide opaque sous l'urine, est de radiographier le sujet dans plusieurs positions. Une image en décubitus dorsal et une en décubitus ventral

suffisent généralement. Il doit être noté que la différence entre ces deux films n'est pas nécessairement conditionné seulement par le changement de place du liquide opaque dans le bassinet. Un rein mobile peut changer de place quand on tourne le sujet, une tumeur peut pousser le rein ou les calices à la pelote, plus fortement quand le sujet est dans une position que dans une autre, etc. Ces éléments aussi peuvent contribuer à compléter notre opinion du cas, si nous explorons le malade dans plusieurs positions.

Quelques auteurs recommandent ce procédé sans donner la raison nommée ci-dessus, pour laquelle on doit tourner le malade dans plusieurs positions. LEB dit par exemple de la pyéloscopie: »Unter fliessender Rotation wird der Patient in mehreren Durchmessern durchleuchtet.» HRYNTSCHAK dit aussi: »By a slight rotation of the body, pathological processes can be brought more clearly into the projection on the X-ray film.» Mais malgré cette prudence H. n'a pas marqué qu'il ne s'agit pas seulement d'une autre projection, mais que le contraste par la rotation remplit d'autres parties du bassinet. Il montre entre autres l'image d'un angle de l'uretère qui n'apparaissait que durant l'injection du liquide opaque, sans doute parce qu'il était situé à une telle hauteur qu'il a été rempli d'urine aussitôt que l'injection cessait. SCHMIDT fait des pyéloscopies non seulement en décubitus dorsal mais aussi en décubitus ventral, mais ne montre pas pourquoi les images sont différentes dans ces deux positions. SGALITZER indique qu'on doit radiographier le bassinet dans deux directions, l'une à l'angle de l'autre (c'est à dire avec une direction des rayons aussi bien sagittale que frontale). A en juger de ses clichés il est probable que S. obtient l'image de profil en tournant le malade sur le côté. Mais lorsque plus tard, dans une publication avec HRYNTSCHAK, SGALITZER recommande au contraire de compléter l'image qu'on obtient par la direction sagittale des rayons par un film pris en direction oblique, ce dernier semble être fait par un penchement du tube. S. a donc quitté la méthode qui aurait pu écarter au moins dans une certaine mesure des sources d'erreurs qui naissent de la stratification du liquide opaque sous l'urine. Ces auteurs cherchent surtout à étudier le bassinet dans différentes projections, mais ils ne remarquent pas l'importance d'un changement de position du sujet pour obtenir différentes parties du bassinet remplies du liquide opaque.

Si on commence par l'injection du liquide opaque et la radiographie dans le décubitus dorsal, il arrive facilement que le liquide opaque quitte le bassinet quand le malade est tourné sur le ventre. Il faut alors parfois ajouter encore plus de liquide. Il est à remarquer que bien des fois, malgré que le malade change de position, le liquide opaque et l'urine ne se mélangent pas pendant ce mouvement, ce qu'on voit de la figure 11, où il n'a pas été injecté de nouveau contraste après le changement de position.

Surtout parce qu'on doit éviter le risque d'un remplissage trop fort et qu'on doit avec le moins de liquide opaque possible chercher les renseignements qu'on désire du bassinet, je considère la radiographie en plusieurs positions très avantageuse. Pour que le malade soit tout à fait mobile sur la table il faut que le cystoscope soit éloigné, après que les sondes ont été placées et que le malade soit laissé dans les mains du radiologue. Cet éloignement du cystoscope semble aussi opportun au point de vue humanitaire.

Peut-être les points de vues nommés ci-dessus peuvent-ils avoir une autre importance que seulement pour l'interprétation de pyélographies. Dans le décubitus dorsal le psoas forme, comme j'ai remarqué auparavant, un seuil pour l'issue de l'urine du bassinet. Dans cette position la musculature du bassinet devient la seule force qui puisse le vider et les éléments formés de l'urine sédimentent dans les parties du bassinet les plus éloignées de l'issue. La conséquence en est que des malades avec une pyélite et avec un dérangement de la motilité du bassinet ne doivent pas, s'ils sont couchés, rester toujours sur le dos mais être tournés souvent. — Théoriquement le drainage du bassinet doit être amélioré en décubitus ventral. Je n'ai cependant pas eu l'occasion d'appliquer cette méthode en pratique.

RÉSUMÉ

L'auteur démontre l'importance du fait que les liquides opaques qui sont utilisés pour la pyélographie rétrograde ne se mélangent avec l'urine qu'avec une certaine difficulté. Appuyé sur plusieurs images il montre, comment le liquide opaque injecté forme souvent une couche de fond dans le bassinet, et comment au-dessus de cette couche existe une autre couche formée d'urine qui n'est pas mélangée avec le liquide opaque. Pour éviter des fautes dans l'interprétation le malade doit être radiographié dans plusieurs positions du corps.

SUMMARY

The author shows how the contrast fluids used for retrograde pyelography only with difficulty mix with the urine. Supported by some pictures he shows how the contrast fluid sinks to the bottom of the renal pelvis with a covering layer of urine. To avoid errors the patient ought to be X-rayed in several positions.

ZUSAMMENFASSUNG

Verf. macht darauf aufmerksam, dass die Kontrastflüssigkeiten, die bei der retrograden Pyelographie verwendet werden, sich nur mit einer gewissen Schwierigkeit mit dem Urin mischen. Mit Hilfe mehrerer Bilder wird gezeigt, wie die eingespritzte Flüssigkeit zum Boden des Nierenbeckens sinkt und wie sich eine Schicht von stagnierendem Urin über dieselbe lagert. Um falsche Deutungen zu vermeiden wird der Patient in mehreren Körperlagen photographiert.

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Fig. 5 a.

Fig. 5 b.

Fig. 6 a.

Fig. 6 b.

AC

Fig. 7 a.

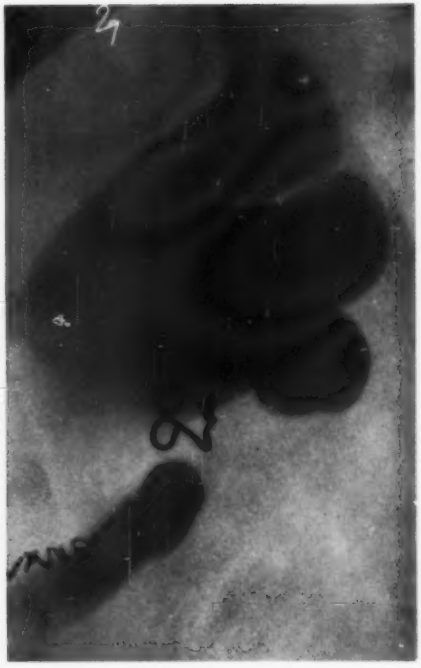


Fig. 7 b.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11 a.

Fig. 11 b.

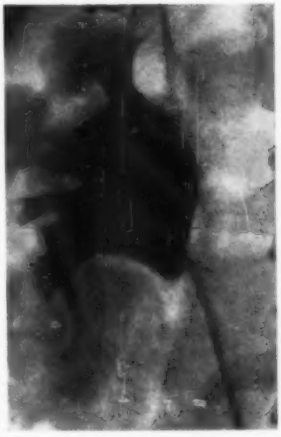


Fig. 12 a.

Fig. 12 b.

Fig. 12 c.

Fig. 13 a.

Fig. 13 b.

Fig. 14 a.

Fig. 14 b.

Planches

I.

Figure 5 a: Sur un malade posé sur le côté gauche a été injecté par une sonde dans le bassinet gauche 8 cc. de solution d'abrodil. La sonde n'atteint pas le bassinet. Dans la partie supérieure de l'uretère existe une petite bulle d'air qui y est entrée involontairement. On voit que le liquide opaque coule dans un fin courant sous cette bulle d'air et qu'une fois dans le bassinet il coule en traversant l'urine directement au fond où il s'assemble dans une couche avec un niveau supérieur horizontal.

Figure 5 b: Le malade a ensuite été posé sur le dos. Observez l'apparition et la position de la bulle d'air qui pourrait facilement être prise pour un calcul.

Figure 6 a: La sonde urétérale est placée avec son bout dans un calice supérieur du bassinet et le liquide opaque est injecté pendant que le malade est placé avec les pied du lit élevés.

Figure 6 b: Après l'abaissement des pieds du lit de nouvelles parties du bassinet se font voir, qu'on ne pouvait pas voir auparavant.

II.

Figure 7 a: Bassinet élargie avec peu de liquide opaque.

Figure 7 b: Le même pendant le remplissage continué de liquide opaque.

Le trajet de l'uretère n'est parfois pas visible parce que celui-ci est plein d'urine.

Figure 8: Le liquide opaque s'est assemblé dans une partie supérieure du bassinet. C'est seulement une petite quantité du liquide qui a pu traverser la cloison (comparéz avec la fig. 1) qui le sépare de la partie voisine du bassinet où il est descendu au fond et s'est posé en rond autour d'une papille rénale.

Figure 9: Une image typique du liquide opaque qui est descendu dans les parties les plus basses du bassinet et de l'uretère.

III.

Figure 10: La stratification du liquide opaque et de l'urine peut apparaître aussi dans un bassinet de grandeur normale.

Figure 11: Pyélographie.

a. en décubitus dorsal. b. en décubitus ventral.

Par cette méthode on obtient des images de la partie dorsale et de la partie ventrale du bassinet. Observez le mélange insuffisant même après que le malade a été tourné.

Figure 12: »Psoasrandsymptom» de Hutter et son explication. Voir le texte.

a. décubitus dorsal. b. décubitus ventral. c. la même position que b. après le remplissage d'encore plus de liquide opaque; en même temps de l'air est aussi entré dans le bassinet et s'est placé dans les parties dorsales.

IV.

Figure 13: Pyélographie.

a. en décubitus dorsal. b. en décubitus ventral.

Dans le dernier cas on voit surtout très distinctement l'issue du bassinet dans l'uretère.

Figure 14. Pyélographie dans un cas d'obstacle dans la partie proximale de l'uretère.

a. en décubitus dorsal. b. en décubitus ventral.

Dans la première position on voit seulement les calices, dans la seconde l'ampoule du bassinet et l'uretère (jusqu'à l'obstacle) remplis de liquide opaque.

FROM THE ROENTGEN DPT. OF THE COUNTY HOSPITAL, VÄNERSBORG, SWEDEN

THE ROENTGEN KYMOGRAM OF THE NORMAL HEART[1]

by

C. G. Sundberg

Read at the meeting of Nordisk Förening för Medicinsk Radiologi in Stockholm June 29th 1933

(Tabula LXXIV)

Among the authors, who have worked with roentgen kymography of the heart ever since SABATT's and GOETT & ROSENTHAL's first experiments 20 years ago, PLEIKART STUMPF is the only one, who has worked out a method for practical use.

STUMPF's »surface kymograph» has the advantage of giving a certain general survey of the distribution over the heart contours of the different types of pulsation. This method, however, is not suitable for a closer analysation of the kymogram, as the curve is very concentrated — one whole heart cycle takes a space of only a few mm! — so that all finer details necessarily must be extinguished.

After some earlier experiments with a single slit, in constructing the kymograph, which I finally made use of, I adopted STUMPF's idea of several parallel slits, which however are separated by larger intervals, i. e. 30 mm.

The speed of the film-cassette is adjusted so that 2 or 3 pulsations are recorded in the available space of nearly 30 mm. A whole heart cycle corresponds then to 10—15 mm, which with ordinary pulse rate is about half as much as an electrocardiogram's ordinary length for the same period. The rate of the film is under these conditions about 15—20 mm/sec.

A study of the conditions for an exact reproduction of movements by X-ray kymography has apparently not been made hitherto.

Let us suppose that the X-ray machine gives 100 exposures per sec. and in order to simplify the problem assume these exposures to be

[1] Submitted for publication Sept. 9th, 1933.

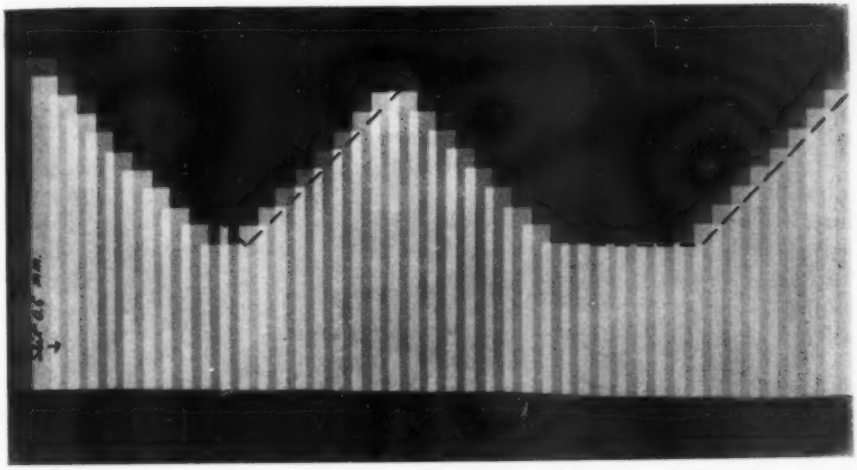


Fig. 1 a.

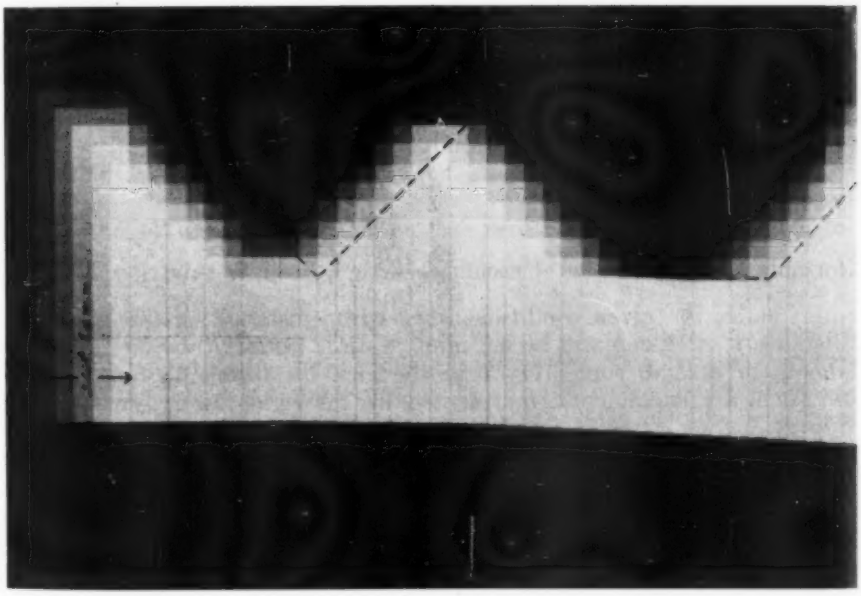


Fig. 1 b.

momentary. It is then evident that with a film rate of r mm/sec. and a slit breadth of r/100 mm, one must obtain a series of momentary pictures which follow each other without covering each other to any extent. If the rate of the film is 20 mm/sec., a slit of 0.2 mm would be sufficient. Under these conditions the kymogram would reproduce all movements which last more than 0.01 sec.

With the power allowed a 10 KW tube however, one single discharge does not give sufficient density in the film. It is necessary to have a slit breadth of ½—1 mm and thus several exposures (3—5) which in part cover each other. This causes a deformation of the curve as is shown in figg. 1 a and b. The real course of the movement is indicated by the dotted line but apparently the curve would be read in another way. As is seen, both the wave-length and the amplitude tend to be diminished.

STUMPF's kymograph has a slit breadth of 0.5 mm. The film rate is 12 mm in 3 sec., thus about 4 mm/sec. In these conditions 12.5 exposures are obtained for each slit breadth. We then get 13 pictures partly covering each other. As the contour of the heart shadow may move with a speed of 10—20 mm/sec., it can be displaced over 2 mm during this time.

Fig. 2 shows kymograms of a pulsating waterfilled rubber ball, the right contour through a 0.2 and the left through a 1 mm wide slit, thus resp. 1 and 5 exposures per slitbreadth on the film. Both of the upper kymograms were taken with broad focus tube (10 KW), the two lower ones with a fine focus (1.5 KW).

The haziness of the outline (»Randunschärfe») which is caused by the size of the focus, appears as a gradual fading away of the heart contour towards the pulmonary field in the direction of the slit, which furthermore intensifies that distortion caused by the pictures of different phases of movement being stored over each other. According to the well-known formula $u = \frac{b \times d}{f - b}$ the »Unschärfe» with a 10 KW-tube (focus $d = 4$ mm) under the given conditions (target-film distance $f = 90$, heart-film distance $b = 15$ cm) will be 0.8 mm. With a Rotalix-tube one probably should be able to come very near the ideal conditions for reproduction of the heart movements (represented by the right lower kymogram in fig. 2).

For the interpretation of the kymogram it is necessary to take an electrocardiogram (or some other well-known record) simultaneously. Earlier experiments have met with much trouble because of disturbances caused in the galvanometer circuit through induction from the X-ray machine. STENSTRÖM and WESTERMARK's experiments, wherein the disturbances were eliminated by a compensating arrangement, are as yet among the most successful. In my experiments I have used Elema's

transportable electrocardiograph. If this is adjusted to a low sensibility the disturbances will not be larger than that at least the R- and T-waves are plainly visible even during X-ray exposure, while the auricular wave is usually lost. The disturbances show the length of the registration on the electrocardiogram (se fig. 14). With a common photographic

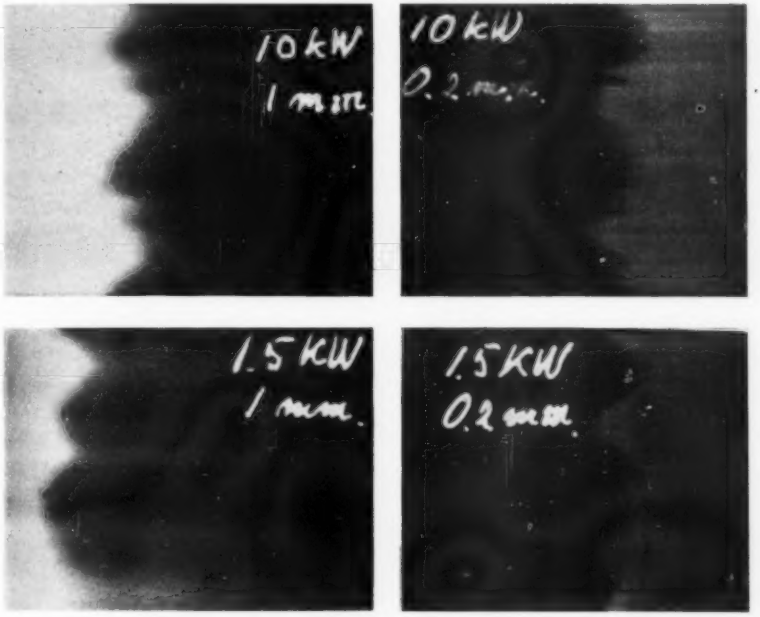


Fig. 2.

magnifying apparatus a copy of the kymogram is made, enlarged to the same length as the Ecg. and both curves can then be directly compared. Still simpler is to minimize the Ecg. to the same scale as the kymogram with millimeterpaper and draw in the Ecg. on the kymogram (as is done in fig. 15).

A diagram of my apparatus is shown in fig. 3. A bromide paper or a film is placed between the lead plate with the slits and the thorax wall. After the kymogram is made and the cassette is taken away, another exposure is made through the slits. In this way a »key» to the kymogram is obtained, with the position of the slits exactly reproduced on the heart shadow.

As for the comparison between the kymogram and the Ecg., it is necessary to have both the beginning and the end of the exposure on the moving film, the exposure is started and stopped by a switch in connection with the cassette, as the diagram indicates.

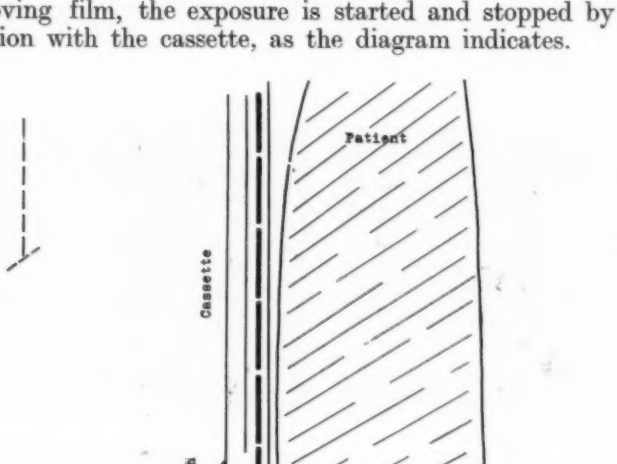


Fig. 3.

II. Experiments with the heart of dog

To understand the kymogram it is necessary to be acquainted with the pulsations which take place inside the heart shadow and are not visible on the outlines. As early as 1891 HAYCRAFT showed by aid of »acupuncture» that the apex is a comparatively immobile point, while the ventricle bases make large systolic deflections in a baso-apical direction. Since the roentgenologists began to study the movements of the outer contours, so much interest was paid to these comparatively small pulsations, that the far more important ones of the auriculo-ventricular border were mostly entirely forgotten. This explaines, e. g. that some authors took up the absurd idea of calculating the systolic output by the outline pulsations. The first roentgenologist, who percieved the great importance of the movements of the auriculo-ventricular septum, seems to be LAURELL. As I have earlier shown by some experiments on animals

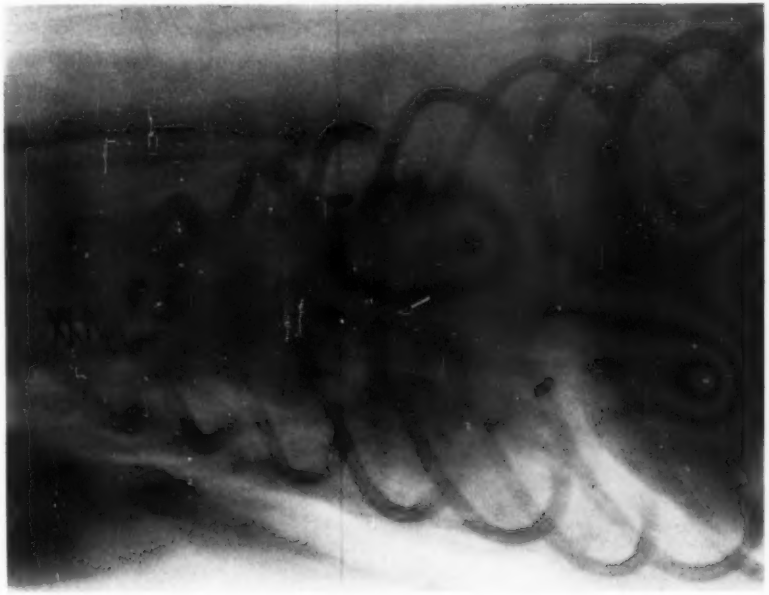


Fig. 4 b.

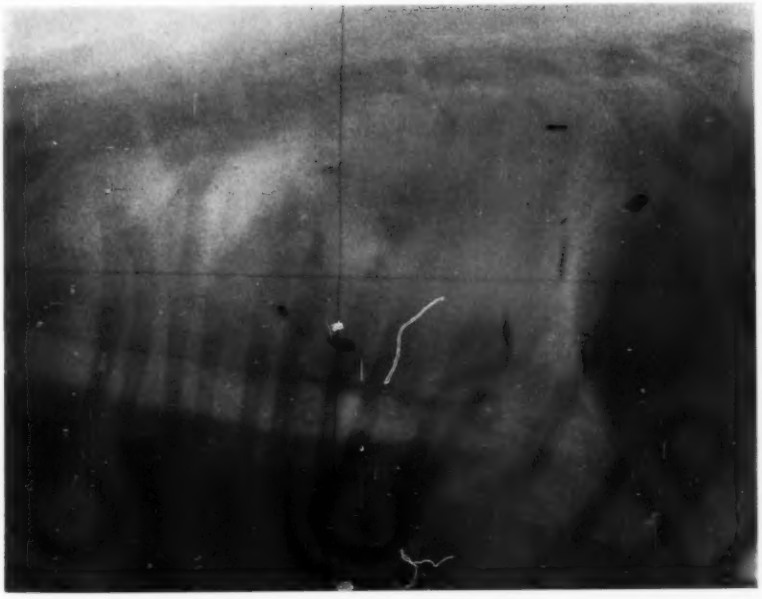


Fig. 4 a.

(rabbits) made in LAURELL's institute 1928, they can be studied and recorded by injecting a few drops of lipiodol in the pericardial sac.

In order to study the movements of the heart *in situ* more minutely I later made a series of experiments on dogs.

Artificial respiration by intratracheal insufflation being maintained the chest was opened under ether anesthesia. After cutting open the

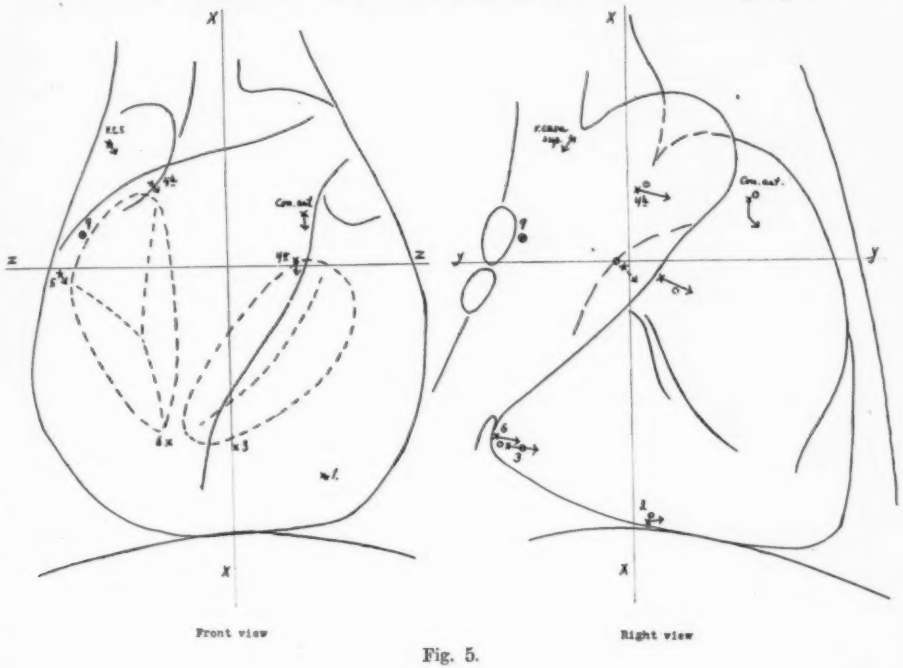


Fig. 5.

pericardium small lead pieces were applicated at selected points in the heart wall (cf figg. 4—6). Then the pericardium was sewn together, the lungs blown up and the chest closed. The dogs recovered very soon after the operation, and walked around, drank water and so on. As it was impossible to avoid small remnants of air in the pleural cavities and as even a small pneumothorax may interfere with the heart movements, the original plan was to let the dogs live until the air was absorbed. In spite of quite sterile technique the animals, however, contracted pericarditis and pleuritis after a day or two. It was therefore necessary to make the experiments within a few hours after the operation.

After an intraperitoneal dosis of barbital sufficient to give a slight anesthesia, the dog was placed on the fluoroscopic table lying on its side.

One X-ray tube was placed under the table and another behind the animal. Over and in front of the animal two frames were placed in two perpendicular planes, each frame holding a right-angular cross of thin steel wires. The tubes and frames were adjusted so that each central ray cut the intersection of the wires on the corresponding frame perpendicularly to the plane through these wires and the intersection of the central rays fell in the heart. On each frame one wire was parallel to the longitudinal axis of the animal, the other parallel to its sagittal, resp. transversal plane. The frames were used as holders for two film cassettes. The films were exposed one after the other during a respiratory pause but over 2—3 heart cycles. Thus the turning points for the marks are obtained on the films and sometimes also some intermediat peoints of their course, where the movement has been comparatively slow (cf the kymograms fig. 4).

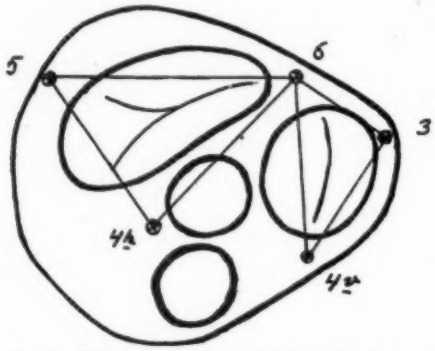


Fig. 6. The bases of the ventricles with the location of the lead marks (exp. 28).

Tab. I. (Exp. 28)

Ostium venos. dxt.	Systole	Diastole	Diff. Di-Sy.	Vagus-excitation	Diff. Vag.-Sy.
4h—5	19.4 mm	19.3	— 0.1	21.8	+ 2.4
5 —6	33.2 mm	34.9	+ 1.7	34.3	+ 1.1
6 —4h	39.7 mm	40.0	+ 0.3	39.8	+ 0.1
△ 4h—5—6	324 mm²	337	+13	376	+52
Ostium venos. sin.					
4v—3	29.7 mm	31.5	+ 1.8	31.7	+ 2.0
3 —6	9.5 mm	9.2	— 0.3	11.2	+ 1.7
6 —4v	32.0 mm	34.5	+ 2.5	38.1	+ 6.1
△ 4v—3—6	140.5 mm²	142	+ 1.5	158	+17.5

From such a pair of films (fig. 4) it is possible to calculate exactly the distance between two marks, the amplitude of the pulsation of a mark and so on. (The calculation is made according to the formula $\sqrt{(x_a - x_b)^2 + (y_a - y_b)^2 + (z_a - z_b)^2}$, x_a, x_b, etc. being the coordinates to the points a and b after correction for the enlargement in the radiogram.)

Fig. 5 shows a dog heart seen from the front and from the right side. The arrows indicate directions and amplitudes of the systolic movements

in their projections on the frontal and sagittal plane resp. Marks 1 and 9, which indicate the apex and the dorsal auricular wall resp., stand still, while the marks placed round the bases of the ventricles move in an apical direction.

By a stereometric calculation it appears that the marks 5 and 3 placed along the lateral borders of the heart are more displaced than those on the anterior and the posterior surface of the heart, that is correspond-

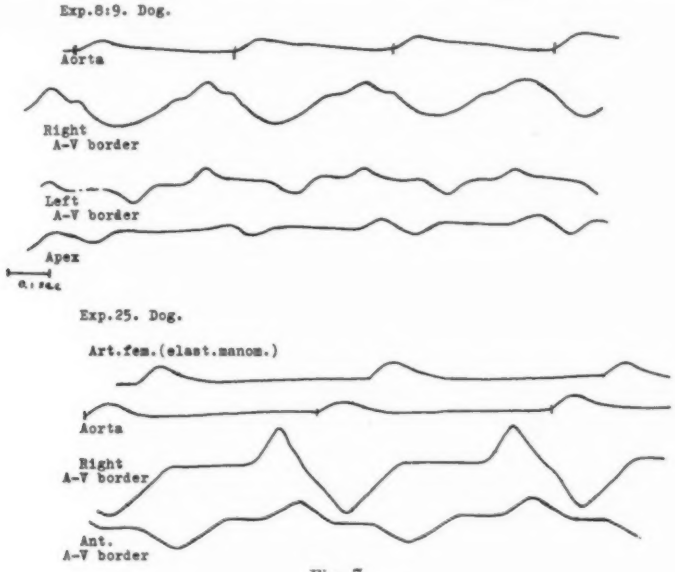


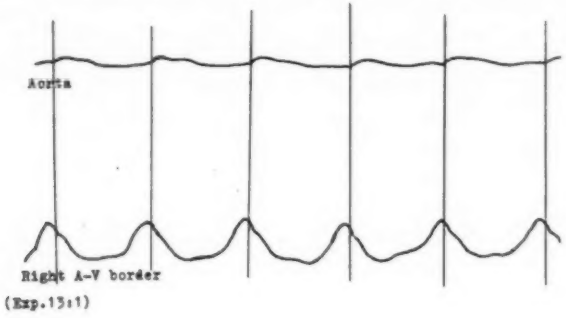
Fig. 7.

ing to the anterior (4) and the posterior (6) parts of the base of the inter-ventricular septum.

The movements apparently are comparatively small in these experimental conditions as the heart probably does not work with the normal pulse volume after the operation (the blood pressure was however normal). After an injection of adrenalin there was a large increase of the amplitude. (Cf. also the experiments with lipiodol.)

A mark in the angle between v. cava sup. and the right auricular roof makes during the auricular systole a movement backwards and downwards, which shows that the orifice of the vein is reduced in size during the auricular systole. This pulsation seems to be caused by some more delicate mechanism and will often stop long before the heart action shows any other disturbances.

Fig. 6 and tab. I show that the auriculo-ventricular orifices also become smaller during systole. It is true that the differences are slight but a comparison between the systolic width and the width during vagus excitation shows that there are greater possibilities of variation.



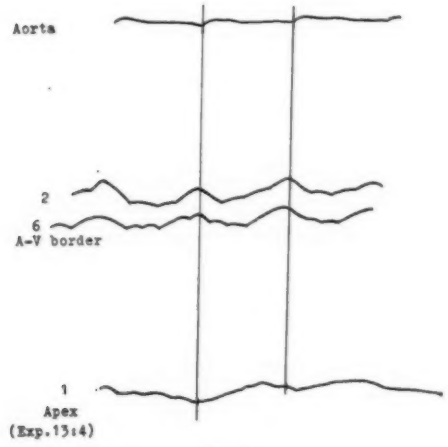


Fig. 8.

It is possible to follow these movements closer on a kymogram, when the marks are projected on the slit. Fig. 7 and 8 show such curves. In the experiments 8 and 25 we see a standstill at the end of the diastole (»diastas») which is interrupted by a deflection which apparently corresponds to the auricular systole. On dying hearts where a block has formed I have seen this presystolic elevation of the A—V border isolated. The systolic descent of the A—V border is sooner or later accom-

panied by an upward movement of the apex. Sometimes this can be preceded by a downward one (cf also the lipiodol kymogram fig. 10), probably an expression of the heart's change of shape during the period of rising tension.

The kymogram fig. 9 is made with the lipiodol method with synchronous recording of the electrocardiogram with string-galvanometer. Because of the disturbances it was not possible to read the Ecg. during

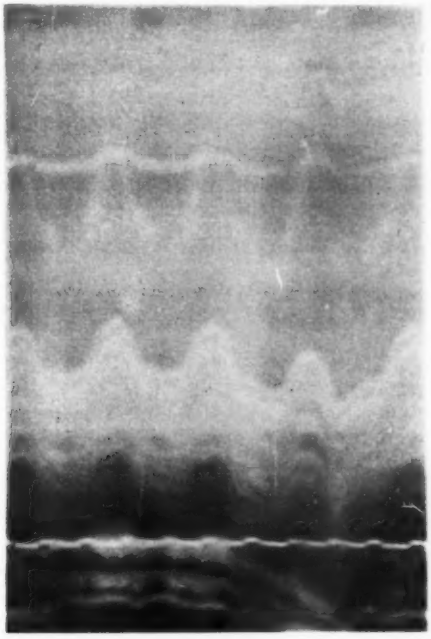
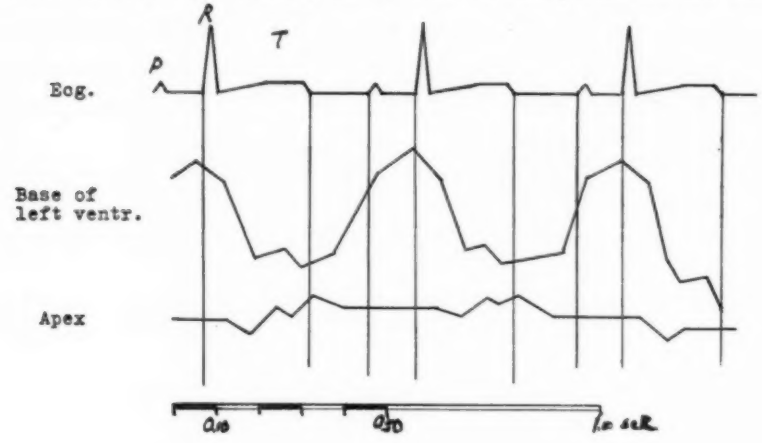


Fig. 9.

the X-ray exposure, so that the P, R, and T-waves had to be interpolated as shown in fig. 10.

These investigations give a picture of the functioning of the auriculoventricular valves, which is illustrated in fig. 11. During the presystole the open-standing valves are drawn up over the blood column in the orifice causing a certain tension in the ventricular wall, just as when the thorax is brought over by the inspiratory muscles from its elastic equilibrium to a position of inspiration. When the auricular muscle relaxes, the annuli fibrosi spring back to their position whereby the valves must be pressed against each other and close. This must be supposed

to happen irrespective of whether a contraction of the ventricles follows or not. If such a contraction follows, the movement of the closed valves continues downwards. During the period of rising tension the ventri-



Exp.18/1. Dog. Lipiodol in the pericardium.

Fig. 10.

cular part of the heart must be assumed to tend towards a spherical form (the most advantageous relation between surface and volume) with the side walls bulging out. This may be an explanation to the often in the beginning of systole existing outwards directed movement of the outline. Following this we see a concentrical contraction of the ventricles' base and sides at the same time as the blood flows out into the aorta resp. the pulmonary artery.

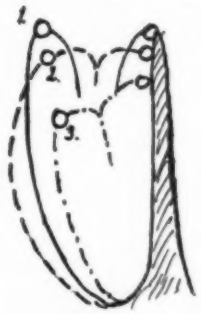


Fig. 11.

1. Presystole.
2. Period of rising tension.
3. End of ventricle systole.

These investigations refer, of course, to experiments with animals. Injection of opaque mediums in the pericardium is certainly too hazardous to be done on human beings. Lipiodol injections are impossible as they after some time cause an exsudation in the pericardium. By chance the other method once came in use on a human being. I refer to a case observed by ZEZSCHEWITZ where a shell fragment had fastened in the dorsal ventricle wall near the base. The movements here correspond evidently very well with those I have observed and recorded. Z.'s case was misinterpreted by himself, but was later

explained by LAURELL. Perhaps it may become possible with a finer technique to observe the movements of calcified foci in the heart.

Fig. 12.

III. The normal kymogram of the human heart

Fig. 13—15 show that kymograms from different parts of the heart are more or less different. In trying to interpret them, we must remember that the conditions are here very complicated. When the movement does not go in the same direction as the slit the kymogram is bound to be distorted. As the heart also probably makes a rotative movement about ist own longitudinal axis, it is possible that different parts of the heart with various types of movements form the outline successively and thus become projected on the slit. The displacement of the A—V

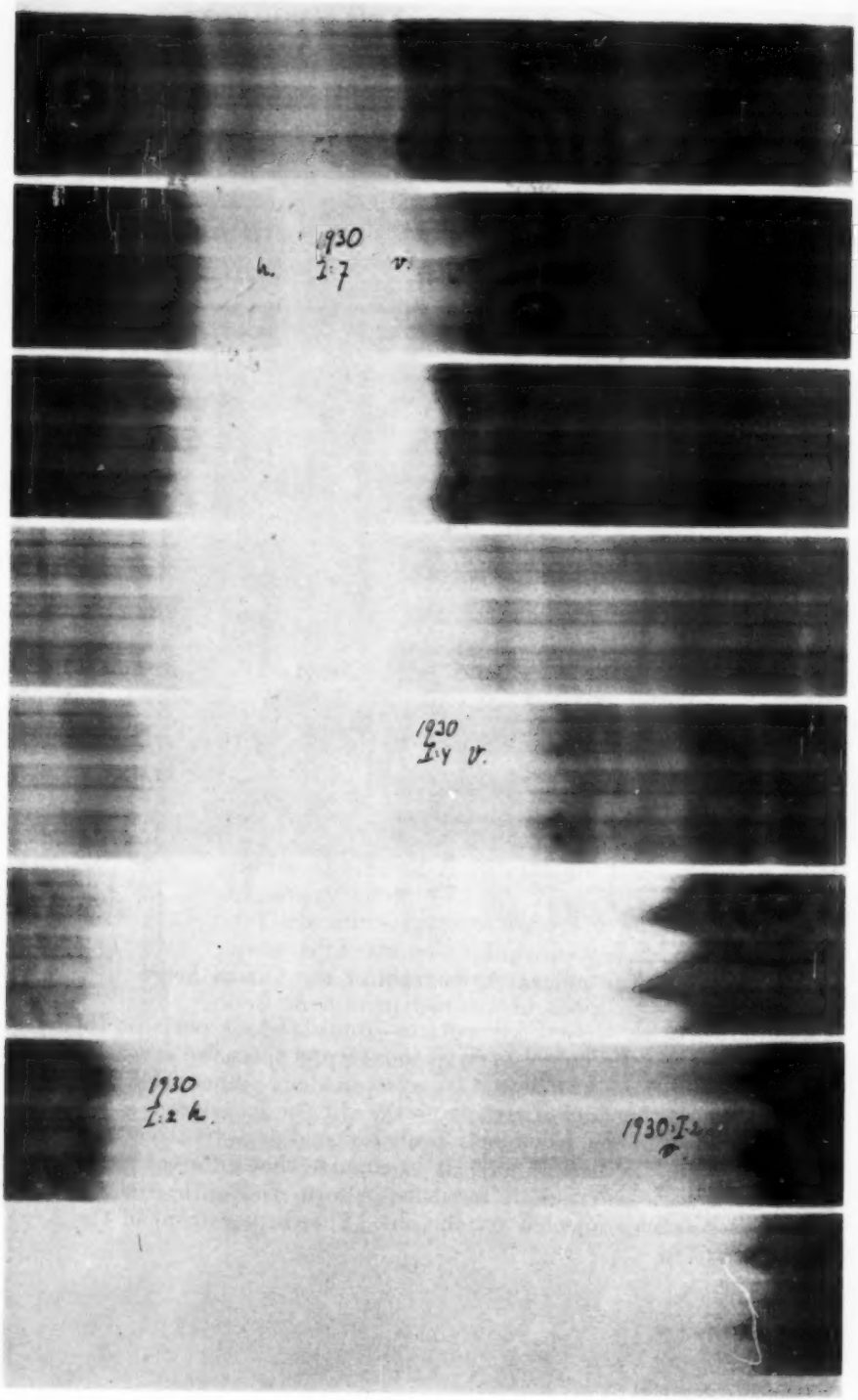


Fig. 13.

border in a baso-apical direction operates in the same way. We must in the first place limit our analysis to more typical parts.

It is easiest to interpret the *aorta kymogram* which corresponds to the pulse curve. The dicrotic wave does not always appear distinctly. (Cf. fig. 14.)

The *ventricle kymogram*. — It has earlier always been assumed that the left ventricle outline moves inwards during systole and outwards during diastole. The inward movement, however, usually starts just

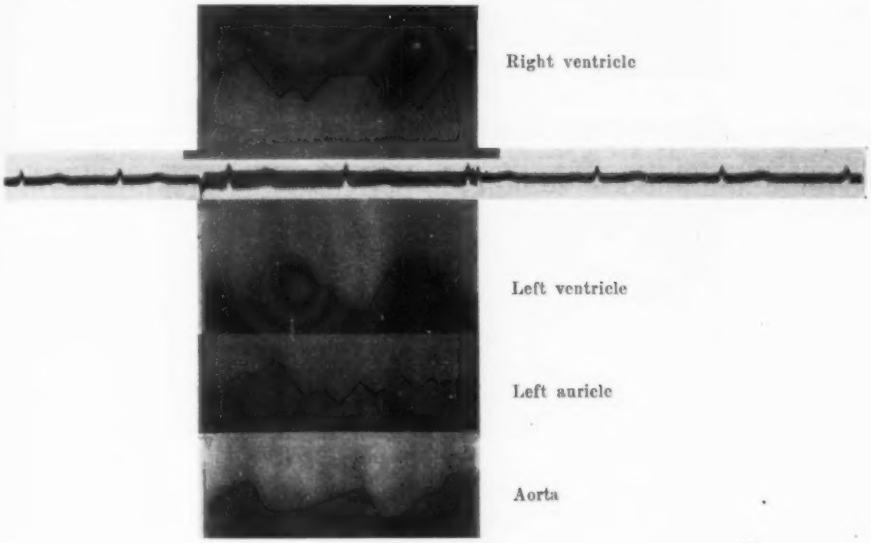


Fig. 14.

when the systolic output begins. During the period of rising tension the curve shows a plateau (fig. 14) or quite often a sharply defined outwardly directed deflection (fig. 15). The latter is evidently identical with the apex beat, which is palpated and recorded from the thorax wall. The reason for this is usually considered to be a displacement of the ventricular part forwards to the left caused by a sort of erection of the heart during the muscular contraction. It is also possible that it is due to the change in shape of the heart of which I have spoken in connection with my animal experiments. — A propulsion of the ventricular wall in connection with the beginning downward movement of the A—V septum.

At the turning point between the systolic inward and the diastolic outward movement there is sometimes a small positive wave, which

begins at the end of the T-wave in the Ecg. This is synchronous with a similar wave, which can be found in the apex beat curve and is supposed to be connected with the closing of the semilunar valves, a counter stroke

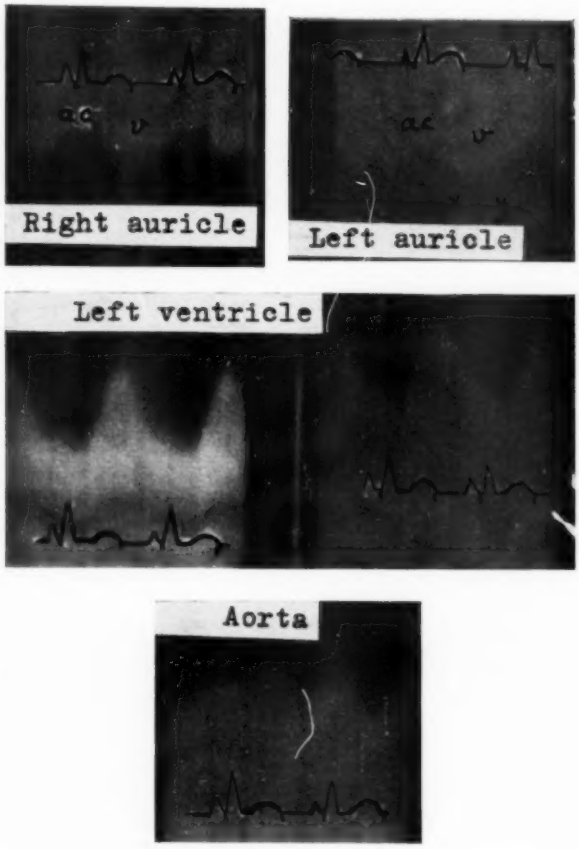


Fig. 15.

of the blood column against these valves, the effect of which is transmitted to the apex.

On the diastolic stroke the auricular systole sometimes appears.

In a paper just lately out ZDANSKY and ELLINGER have identified the ventricle kymogram with the volume curve of the ventricles reproduced from STRAUB.

That is certainly taking it too schematically, especially as such curves are recorded under unphysiological conditions. I should rather think that FREY's interpretation of the apex beat curve as an interference between the changes in volume and shape of the heart, is applicable even to the ventricle kymogram.

The *auricle kymogram* finally presents some likness to the venous pulse curve (fig. 15). Often we find both the a-, c-, and v-notches represented as positive waves — that is, outwardly directed. It is however more likely that the auricular systole corresponds to the deflection between a and c (thus an inwardly directed movement). Often a and c flow into each other. The negative wave »x» between c and v is of special interest. It appears in the latter part of the ventricular complex on the Ecg. and ceases almost simultaneously with T. In the venous pulse curve this is interpreted as an expression of the A—V valves' descending movement, which at the same time as it signifies an effect of pressure on the contents of the ventricle, produces an effect of suction towards the auricles and by way of them to the veins. It varies in size, which probably corresponds to the more or less free blood inlet to the auricles. By fluoroscopy I have seen many times that it is large in upright and diminishes in horisontal position, especially in asthenical persons with drop heart (LAURELL's »arterial anemia»).

The positive v-notch, which now follows, appears during the relaxation, while the as yet closed A—V valves go upwards. Its transition in a negative direction (»y») probably signifies the opening of the A—V-valves and the beginning of the flow of blood from auricle to ventricle. Towards the end of the diastole the auricle again expands with blood flowing in from the veins.

It is very likely that a continued study of the kymograms will aid in the interpretation of other curves, which now appear to be entirely too complicated. But I believe that even these, here described, aorta-, ventricle-, and auricle-kymograms will be of great value in analysing pathological cases.

The experimental work was done partly at the Physiological Dpt of the Univ. of Chicago (Chief: prof. CARLSSON) where I had an opportunity to stay thanks to an Anders Zorn-fellowship from the Scandinavian-American Foundation. Some experiments were also made in the Roentgen Dpt of the Univ. Hospital of Upsala (Chief: prof. LAURELL) with aid of apparatus from the Physiological Dpt. (Chief: prof. GÖTHLIN). For the kymograph I had a grant from the Regnell's Fund, Upsala.

SUMMARY

The author has investigated the conditions under which kymograms should be taken in order to exactly reproduce the displacements of the heart outline, and describes an X-ray kymograph with an apparatus for recording the electrocardiogram simultaneously. In animal experiments, dogs, the movement in the different parts of the heart, especially the auriculo-ventricular border, has been examined and recorded (basal kymogram). By stereometrical calculations on X-ray photos of for this purpose prepared animal hearts in situ, the changes in the width of the orifices have been studied.

The X-ray kymogram of the human heart has been analysed by comparison with a synchronously recorded Ecg. and the interpretation of the aorta-, auricle-, and ventricle-kymogram has been discussed.

ZUSAMMENFASSUNG

Verf. untersuchte die Bedingungen, unter welchen Kymogramme aufgenommen werden sollten, um die Verschiebungen der Aussenlinie des Herzens genau zu reproduzieren, und beschreibt einen Röntgenkymographen mit einem Apparat zur gleichzeitigen Schreibung von Elektrokardiogrammen. In Tierversuchen, an Hunden, wurde die Bewegung der verschiedenen Teile des Herzens, besonders der Atrio-Ventrikular-Grenze untersucht und registriert (Basis-Kymogramm). Durch stereometrische Berechnungen an Röntgenphotographien von Tierherzen, die zu diesem Zweck in situ präpariert waren, wurden die Veränderungen der Weite der Orifizia studiert.

Verf. analysiert das Röntgenkymogramm des menschlichen Herzens durch Vergleich mit einem synchron registrierten Ekg. und erörtert die Deutung der Aorten-, Vorhof- und Ventrikelkymogramme.

RÉSUMÉ

L'auteur a étudié les conditions dans lesquelles doivent être pris les kymogrammes dans le but de reproduire exactement les déplacements des contours cardiaques et decrit un kymographe radiologique ainsi qu'un appareil permettant de prendre simultanément un électro-cardiogramme. L'auteur a étudié chez le chien le mouvement des diverses parties du cœur et plus spécialement le bord auriculo-ventriculaire (kymogramme basal). Des calculs stéréométriques faits sur des radiographies sur des cœurs d'animaux préparés à cet effet in situ ont permis d'étudier les modifications de largeur des orifices.

L'auteur a étudié le kymogramme radiologique du cœur humain par comparaison avec un électro-cardiogramme synchronisé; il discute les kymogrammes de l'aorte, de l'oreilette et du ventricule.

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CHIEF: DR. J. HEYMAN

RECURRENCES AFTER FIVE YEARS CURE IN CARCINOMA OF THE CERVIX RADIOLOGICALLY TREATED[1]

by

Kjell Lauritzen

It is a well known fact that the five-year limit generally accepted for estimating the result of treatment in cancer of the cervix, does not mean a definite freedom from recurrence after that period. On the contrary, ever since the first days of modern therapy in cervical cancer, repeated observations of recurrence have been made long after the five years. Publications on this subject have, however, usually been concerned with histories of *single* cases. In a number of statistical reports the presence or absence of late recurrences is mentioned but as a rule insufficient details are given to allow an accurate conception of the frequency etc. of late recurrences. Summaries of a *large number of cases* systematically followed for a long time beyond the five-year limit have only exceptionally been published. These have naturally been concerned with *operative* treatment; there are very few observations on *radiological* treatment.

The object of this paper is to make a contribution to the knowledge of the further fate of the five-year cases on the basis of the total number of cases of carcinoma of the cervix radiologically treated at the Radiumhemmet. It is true that FORSSELL in LAZARUS' handbook has already touched on this field and has partly used the same material. In his broad survey of the permanency of radiological cure in malignant growth, he was not concerned, however, with details regarding late recurrences in carcinoma of the cervix.

The following is an introductory resume of some of the more important papers in this field.

BUSSE (1912). Operative treatment. 19 cases cured for five years or more. 14 of these observed 7 years, the rest 6 years. One case recurred after 6 years.

WEIBEL (1914). Wertheim operation. 185 five-year cures. No definite data as to observation time, which seemed to reach a maximum of 14 years. Three cases not

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traced. 13 cases died of intercurrent disease (W. includes here a case of »benign hypernephroma»), 13 died of cancer (W. regards 8 as definite recurrences, 3 as almost definite and 2 as either recurrences or new cancers). Added to this, one case of a sarcoma of another part of the body. — 6 recurrences in the 6th, 5 in the 7th and 2 in the 7th to the 8th years. Almost the same frequency of recurrences in the early and more advanced cases; average age on admission low with only 3 cases over 50 years.

THALER (1917). Radical vaginal operation. 72 five-year cures observed for 10 to 15 years (2 cases, which could not be traced, deducted). 10 deaths: 2 from definite recurrences in the 6th and 7th years, 2 probably from recurrences in the 7th and 11th years, 5 from intercurrent disease and one of an unknown cause.

GAYDOUL and SCHMITT (1922). 43 five-year cures (15 after abdominal, 28 after vaginal radical operation) observed for 5 to 12 years. 13 deaths: 5 of intercurrent disease and 8 of recurrence (3 in the 6th, 2 in the 7th and 3 in the 8th — 12th years).

VIOLET (1928). Radical abdominal operation. 9 five-year cures observed for 15 to 19 years. 3 deaths: one of intercurrent disease and two of recurrence after 10 and 14 years.

BONNEY (1929). Radical abdominal operation. 105 five-year cures observed for 5 to 19 years. 16 cases not traced. 8 cases died of intercurrent disease and 11 of recurrence (one of the latter had cancer in the abdomen possibly of extragenital origin). 4 recurrences in the 6th, 4 in the 7th, 2 in the 8th and one in the 11th years. Of the five-year cases, 27 had had metastases in the lymph nodes, while 78 had not. 4 of the former and 7 of the latter developed late recurrences.

KAMNIKER (1932). 374 postoperative recurrences, 23 of them after five years (8 in the 6th, 4 in the 7th, 4 in the 8th and the remainder in the 10th to the 19th years). A few details regarding part of the primary material were given, none as to the time of observation. Thus among 41 cases in stage I, which were vaginally operated, there were 5 recurrences after five years; among 48 similarly operated in stage II there was one. — In 15 cases local recurrence, in 7 cases recurrence in the pelvic lymph node regions and in one case distant metastases.

VOLTZ (1930). Radiological treatment. 222 five-year cures observed for 7 to 12 years: 92 *operable*, of which 2 died of intercurrent disease, 4 of uterine cancer and 5 of »Magenkarzinom»; 69 *borderline* cases, of which 7 died of intercurrent disease, 4 of uterine cancer and 3 of »Magenkarzinom»; 58 *inoperable*, of which 2 died of intercurrent disease, 2 of uterine cancer and 5 of »Magenkarzinom»; 3 *incurable*, of which none had died. Thus altogether, 11 died of intercurrent disease, 10 of cancer of the uterus and 13 of »Magenkarzinom».

LABORDE and WICKHAM (1932). Radiological treatment. 32 five-year cures observed for 6 to 10 years of which one was not traced. One patient died of intercurrent disease one developed a recurrence. Whether this was really a recurrence cannot be determined, since the authors state that all deaths were listed as recurrences unless autopsy showed that there was no cancer present.

The following study is based on the total number of 1016 cases of cervical cancer treated at the Radiumhemmet from 1914 to 1925 inclusive, 222 of which are five-year cures. In our previously published statistics, there were 224 cured cases; two have, however, been excluded: One because a detailed account obtained later showed that symptoms of a recurrence must have appeared two months before the end of the five-year period, the second because a repeated examination of the slide

has proved it to be a sarcoma. All patients have been treated radiologically in accordance with the principles followed at the Radiumhemmet. The method has been published repeatedly. After having passed the five-year period most patients appear for examination at the Radiumhemmet only once or twice a year. Where this was impossible to secure, information was obtained by means of regular correspondence either from the patient herself or from her nearest relatives or occasionally from the examining physician. The condition of every case has been determined during 1932. No case has been lost sight of.

At the close of 1932 out of the 222 cases, 56 had died, 2 were living with recurrences and one was alive and well after having had a late recurrence 3 years ago.

The following principles have been followed in the classification of these 59 cases.

As »*cancer free*» there have been listed only those 24 cases (no. 1 to 24) which, on examination at the Radiumhemmet or according to detailed communications from doctors or relatives, showed no symptoms of cancer either at the time of death or shortly before. Unfortunately only a few cases have been autopsied. This is partly due to the fact that many of the patients died in their homes in the country and partly to the fact that the physician in charge has not considered an autopsy necessary in order to determine the cause of death and to fill in the death certificate.

In 6 cases an autopsy has been done and the absence of cancer proven (cases 5, 9, 13, 14, 20, 22).

In 11 cases the patient died of acute illness (cases 3, 8, 16, 19, 21, 23) or of previously diagnosed organic disease of the heart (cases 4, 6, 11, 12, 24).

In the remaining 7 cases the cause of death is not definitely proven. Two of these (no. 1 and 10) had been cured for 18 and 12 years and carefully followed during this period. They showed such indisputable symptoms of other disease, that cancer could not be suspected as the cause of death. It is also improbable that the remaining 5 cases (2, 7, 15, 17, 18) died from cancer but it cannot be completely excluded on account of the long interval between the last examination and death and on account of the partially incomplete observations.

As *intercurrent cancer* there have been listed cases 25 to 30 where at autopsy, microscopic examination or operation, a later developing *primary* cancer has been demonstrated. An exception is case 27 where the diagnosis, though made by a prominent surgeon as well as by us, was only clinically demonstrated. I have included in this group, for the sake of simplicity, the unusually peculiar case 29 where the new tumor was a sarcoma. Case 34 was also one of intercurrent cancer. Since the patient also had a recurrence the case is placed in the following group.

As *recurrent cancer* have been listed cases 31 to 57, where it must be supposed that a recurrence has occurred after the five-year period even if not definitely proven. There are included here 2 patients (49

and 54) still living with recurrences and one (44) who had a recurrence, which healed after treatment. I have avoided discussing whether each of these 27 cases were recurrences in the real sense of the word i. e. the renewed growth of latent cancer cell masses after a long period of time or the development of a new cancer of the same kind in a predisposed tissue. In my opinion this question is of purely theoretical interest.

Finally, two cases (58 and 59) have been listed as *uncertain* where in spite of a close follow up the cause of death cannot be stated because no autopsy was done.

Table I shows the division into the mentioned groups during the years of the investigation. It should be noted that in 1921 case 44 appears in the recurrence column but that the patient is alive, subjectively and objectively symptom free.

Table I

The number of five-year cases treated from 1914 to 1925 inclusive, with a survey of their subsequent history.

Year	No. of five-year cases	Alive. Have not had rec.	»Cancer free»	Intercurrent cancer	Recurrence	Uncertain
1914	7	3	3	1	—	—
1915	13	6	4	2	1— 7.7 %	—
1916	4	1	—	—*	3—75 »	—
1917	9	5	—	—	3—33 »	1
1918	10	7	2	—	1—10 »	—
1919	20	13	5	—	2—10 »	—
1920	26	20	2	1	3—11.5 »	—
1921	27	18	3	1	5—18.5 »	—
1922	27	21	3	1	2— 7.4 »	—
1923	25	20	1	—	3—12 »	1
1924	35	30	1	—	4—11.4 »	—
1925	19	19	—	—	—	—
1914—1925 . . .	222	163	24	6*	27—12.2 »	2

* In case 34 both an intercurrent cancer and a recurrence appeared. The case is listed only as a recurrence.

The total frequency of recurrence in the five-year cures, after a 7 to 18 year observation period, should therefore be 12.2 %. This figure, however, takes no notice of the fact, that particularly in the first years after the five-year period the possibility of recurrence is not exhausted.[1] Since recurrences seem to occur only exceptionally after 10 years the figures for the ten-year period will be given. Of the 116 five-year cases from 1914 to 1921 inclusive, there were 18 recurrences i. e. 15.5 %. It

[1] An attempt at a closer analysis of the material, with attention to the frequency of recurrences after freedom from symptoms for a longer or shorter time, will be found at the end of this paper.

may be mentioned here, that we have observed one recurrence which manifested itself 12 years and 9 months after treatment, this being the longest interval in our series.

As mentioned above, all cases have been regarded as recurrences where the observations made this diagnosis the most probable. It can be seen from the case histories that the diagnosis was as a rule obvious. Only in two cases has some doubt appeared and these are therefore briefly described. Case 31 was not examined at the Radiumhemmet within a period from 7 months after treatment until death 5 years later. The death certificate gave cancer as the cause of death. It has not been possible to find out on what symptoms this diagnosis was based and thus it is open to doubt whether she died from a recurrence or even from cancer. The supposition of a recurrence is, however, supported by the fact that clinical cure was never confirmed by examination. In case 46 a liver tumor of a clinically malignant type appeared. Naturally, a primary liver cancer cannot be excluded but such a diagnosis is less probable because the condition is so rare. Since no other primary cancer could be found, the case must be classified as a recurrence.

In this connection the interpretation of the patients' condition at the end of the five-year period should be touched upon. If the result of treatment at a certain period is to be expressed in figures, it is unavoidable that a doubt arises in some cases as to whether or not the patient is to be regarded as free from cancer. The decision can be made difficult by the recent appearance of new symptoms whose nature can not be determined; or the patient can have had for a long time subjective or objective symptoms of a more or less suspicious character, originally considered as due to cancer but gradually regarded as harmless because of a long standstill. In the latter case the differential diagnosis is many times impossible, even for one with great experience in cancer and in the changes occasionally appearing after radium treatment. Examples of this are cases 3 and 14 which showed no sign of cancer on histological examination. The changes in these were of the same clinical aspect as those in cases 52 and 53 which later showed their malignant character. In such cases the practical differential diagnosis must rest upon the demonstration of progression or regression when the general symptoms do not indicate the diagnosis. The Radiumhemmet has therefore adhered to the principle of requiring obvious subjective or objective symptoms which according to general experience form the basis for the diagnosis of cancer. The practical consequences of too rigid rules would be absurd, since cases such as 14 and 48 would be regarded as suffering from cancer during the whole period of observation.

Those cases of recurrence will now be listed where any doubt existed regarding the condition at the end of the five-year period. In order

to avoid misconceptions it must, however, be stressed, that many patients now living and well for many years were just as suspicious at the end of the five-year period as the following. In 4 cases the symptoms were more or less recent and too diffuse to justify a diagnosis of cancer: case 34 with increased consistency of the cervix, case 37 with a swollen leg clinically most like a thrombosis, case 40 with an ulceration in the vagina believed to be radium necrosis and case 41 with pain in the legs which was not of the usual cancer type. In six of the cases the suspicious local symptoms had been observed for many years and had not altered: in cases 42, 48, 52 and 53 a slight resistence at the pelvic wall (in order to point out again the difficulty of differential diagnosis it should be noted that in cases 42 and 48 the recurrence did not arise from the suspected nodule and therefore the malignant character of the latter cannot be fully proven), in case 50 a somewhat hard cervix along with a slight roughness in the vagina and in case 55 some small nodules on the outside of the uterus. Finally cases 31 and 43 had not been examined at the Radiumhemmet since the treatment but were subjectively symptom free. No further special attention will be paid to these 12 cases.

Recurrences show no striking predominance in any special age group. The distribution coincides on the whole with that of the entire series of cervical carcinoma. It is only to be expected that the »cancer free» deaths occur more frequently in old patients as shown in table II.

Table II.

Age on admission and cause of death (including recurrence) in the five-year cases.

	Years					
	31—40	41—50	51—60	61—70	71—80	Average
Recurrence	4	9	8	6	—	51.4 years
Intercurrent cancer	1	2	3	—	—	50.2 »
»Cancer free»	—	8	10	5	1	54.8 »

No attempt has been made to divide the cases into subgroups according to the microscopic appearance of the tumors, since no generally accepted or definitely valuable basis for grading has yet been established.

The tendency towards late recurrence does not seem to be associated with any special macroscopic type of tumor. Neither does the predominance of extension of the primary tumor into the parametrium or the vagina seem to be of importance in this respect. A mathematical picture is difficult to arrange because the division would be arbitrary and the groups too small.

Can some relation be shown between the stage on admission and the different causes of death? We have here a more objective basis for

classification in the grouping accepted by the Cancer Commission of the League of Nations.

In table III which summarizes the cases, one is struck by the difference between recurrences and »cancer free» deaths, in that 63 % of the former and only 33.3 % of the latter fall in stages I and II.

Table III

Stage on admission and cause of death (including recurrence) in the five-year cases.

	Stage			
	I	II	III	IV
Recurrence	5	12	10	—
Intercurrent cancer	—	4	2	—
»Cancer free»	3	5	14	2
Uncertain	—	—	2	—

On superficial analysis this would seem to indicate an increased tendency to recurrence for stages I and II or a decreased resistence to the usual diseases of old age for stages III and IV. However, the difference is only apparent and is due to extrinsic causes as the following analysis shows. Naturally the frequency of »cancer free» deaths must increase the longer ago the cases were treated. This is shown numerically in table IV.

Table IV

Comparison of the frequency of the different causes of death (including recurrence) in the five-year cases treated from 1914 to 1919 and from 1920 to 1925 inclusive.

	No. of five-year cases	Recurrence	Intercurrent cancer	»Cancer free»	Uncertain
1914—1919	63	15.9 %	4.8 %	22.2 %	1.6 %
1920—1925	159	10.7 »	1.9 »	6.4 »	0.6 »

About 1920 the cancer of the cervix clientel of the Radiumhemmet underwent a thorough change, in that Swedish gynecologists practically stopped operating on these cases and sent them instead for radiological treatment. This shows itself in the division between operable (including borderline) and inoperable cases. During the period 1914—1919 there were only 20.1 % of the former while from 1920 to 1925 41 % belonged to this group. This also affects the composition of the five-year cases because the inoperable group formed a proportionately larger part from 1914 to 1919 than during later years (table V).

Table V

Frequency of operable (including borderline) and inoperable cases in 1914—1919 and 1920—1925.

	Operable and borderline	Inoperable
1914—1919	25 = 39.7 %	38 = 60.3 %
1920—1925	114 = 71.7 »	45 = 28.3 »

There thus exists a postulate for the increased frequency of »cancer free» deaths among the more severe cases.

In order to study more closely the possible influence on the cause of death and on the tendency to recurrence of the primary anatomical

extension of the tumor one must consider the number of cases of stage I, II, III and IV included in the different groups. Operable and borderline cases have been placed with stages I and II, a justifiable simplification.

The figures for recurrences are shown in table VI.

Table VI

Stage on admission and recurrence in the five-year cases.

	I—II			III—IV		
	No. of five-year cases	No. of recurrences	%	No. of five-year cases	No. of recurrences	%
1914—1919	25	3	12.0	38	7	18.4
1920—1925	114	14	12.3	45	3	6.7
1914—1925	**139**	**17**	**12.2**	**83**	**10**	**12.0**

Thus actually no predominating tendency to recurrence in less advanced cases exists. The difference between 12 and 18.4 % which points in the opposite direction is based on too few cases to be of significance. The strikingly large difference in the frequency of recurrences in earlier and more recent cases in stages III and IV will for the same reason be neglected, particularly since a difference in this direction is to be expected. One can however not exclude the possibility of a real significance, for instance depending on changes in the technique of treatment. Thus in the Radiumhemmet since 1920, the more advanced cases have received roentgen treatment to a greater extent than before, in addition to the usual radium treatment.

The »cancer free» deaths can be studied in table VII.

Table VII

Stage on admission and »cancer free» deaths in the five-year cases.

	I—II			III—IV		
	No. of five-year cases	No. deaths	%	No. of five-year cases	No. deaths	%
1914—1919	25	1	4	38	13	34.2
1920—1925	114	7	6.1	45	3	6.7
1914—1925	**139**	**8**	**5.8**	**83**	**16**	**19.3**

One is impressed chiefly with the predominance of the primarily more advanced cases in the more distant past. Whether this predominance, which is large enough to make the figures statistically significant, has actually any real value can not be decided, partly because of the many sources of error which lie in the variable composition of the primary material. Thus, for example, the significance is dimished by the fact that the average age on admission for the primarily more advanced

cases during the period in question is 52.7, for the less advanced cases 50.5 years.

There seems to be no definite relation between the course of healing due to radiosensitivity and the tendency to late recurrence. It is just as impossible here, as in the question of the significance of the macroscopic type of the cancer, to visualize the matter mathematically. It depends partly on the subjectiveness of the decision as to when the primary clinical cure took place. This is especially illustrated by a case such as 14 where no definite date could be determined.

I shall now give a more detailed account of the recurrences. The localization and the time of onset must be considered. No details of the treatment of the recurrences will be given here. Brachyradium treatment has been used in local recurrences. The remaining cases have received roentgen and in later years teleradium treatment. Besides the purely palliative effect which was sometimes obtained, case 44 deserves especially to be mentioned; it was a superficial vaginal recurrence, histologically verified, and is still healed 3 years after treatment.

The following principles have been used in giving the localization of a recurrence.

As *local recurrences* are classified those cases where the recurrence first appeared in the cervix or adjacent portions of the vagina (Cases 34, 40, 44, 47, 49, 55).

The term *corpus recurrence* needs no explanation (Cases 36, 38).

Recurrences in the connective tissue and lymph nodes of the pelvis have been considered in a broad sense. Thus are included cases such as 33, where there was also extra-pelvic extension. Case 48 has been placed here because the autopsy findings were in favor of a primary recurrence at the pelvic wall with later widespread metastases. In case 41 the symptoms suggested a localization at the pelvic wall although this was never demonstrated at examination. No attempt has been made to separate out lymph node recurrences since this is usually too arbitrary. (Cases 32, 33, 37, 39, 41, 42, 45, 48, 52, 53.)

Indefinable recurrences mean those more or less simultaneously appearing but distinctly separated multiple cancer nodules in the pelvic organs and in the nearest lymph node areas where the original localization of the recurrence cannot be ascertained. In part of these five cases it is impossible to determine whether or not multiple primary recurrences developed and special attention must be drawn to them. In case 35 enlargement of the body of the uterus and skeletal metastases were simultaneously discovered and the time of onset could not be determined, although the skeletal metastases were probably secondary to the corpus recurrence. In case 50 the condition of the cervix had been doubtful for many years and recurrences were simultaneously discovered in the

vagina and at the pelvic wall. Since a definite cervical cancer developed later, the first definite changes were probably metastases of the later manifested cervical cancer. In case 54 the actual time relation between the simultaneously discovered recurrences in the vagina and at the pelvic wall could not be ascertained. In case 56 there was a 6 month interval between recurrences in the vagina and at the pelvic wall. Some months earlier the patient had had a uterine hemorrhage and although the examination and the curettage gave a negative result, this case must possibly be considered as a uterine recurrence with later metastases. Finally in case 57 recurrences appeared both in one inguinal region and at the pelvic wall 4 months after a suspicious vaginal leukoplakia which was healed by radium. In the absence of a histological diagnosis of the »leukoplakia» the case cannot be fully explained.

Distant recurrence includes cancer in the extra pelvic organs, definitely *metastatic* from the cervix. (Cases 46, 51.)

Finally in 2 cases the localization could not be determined since the patients were not examined at the Radiumhemmet (Cases 31, 43).

The localization and time of manifestation of the recurrences is shown in table VIII.

Table VIII

Localization and time of onset of recurrence in the five-year cases.

Localization	Year 5—6	6—7	7—8	8—9	9—10	10—11	11—12	12—13	Total
Local	3	—	1	1	—	1	—	—	6
Corpus uteri	—	—	—	—	—	—	1	1	2
Pelvic connective tissue and lymph nodes	4	3	1	1	1	—	—	—	10
Distant	—	1	—	—	1	—	—	—	2
Indefinable	1	1	2	—	—	1	—	—	5
?	1	—	1	—	—	—	—	—	2
Total	9	5	5	2	2	2	1	1	27

A number of interesting facts are demonstrated in this table. Out of the 20 cases where the original position of the recurrence could be definitely established, 8 recurrences were in the uterus and adjacent part of the vagina while 12 were so situated, that a total hysterectomy following the radiological treatment could not have prevented the recurrence. It must, however, be pointed out that some of the »indefinable» cases were probably originally local. — Patients radiologically cured of cervical cancer for five years rarely develop distant metastases. — Recurrences after radiological treatment can still appear after 10 to 13 years of freedom from symptoms. — Of the 4 recurrences appearing after more than 10 years 3 were certainly and the fourth (case 35) was probably situated

in the uterus and its immediate neighbourhood. Further, the lateness of the manifestation of both cases of corpus recurrence is noteworthy. Also, in case 35 where the recurrence appeared in the eleventh year, the corpus was probably the original localization. This shows a striking agreement with general clinical experience in primary corpus cancer with its tendency (probably governed by anatomical conditions) to slow development as contrasted with cervical cancer.

Some observations can be made on the basis of the time of manifestation of recurrences. The figures given in tables I and VIII do not demonstrate the actual risk of recurrence in cases cured for a shorter or longer period of time. One must also consider how many cases have actually had the possibility of developing a recurrence after a period of for instance more than 10 years. The first condition is that the cases should have been treated more than 10 years ago and that is not sufficient since one must also consider that a number of these cases died in less than 10 years. Even if due consideration is given to these conditions, the figures so obtained make no pretention to general absolute validity, aside from the source of error due to the relatively small number of cases. To continue with the example, those cases which have had a chance to recur after more than 10 years are not uniform in that a part of them have a duration of only 11 years, others 12 years etc. and therefore in regard to the time factor have had different recurrence possibilities. This source of error, which should shift the frequency in the table below (IX) in a favorable direction can be of very little significance, at least in the series from the earlier years. It could be avoided only if one had access to a large number of cases from the same year, where the patients had lived and been followed for a long time. The significance of this error is further diminished by the fact that in table IX the observation period for the whole series now living was reckoned back from the end of 1931. Since the last observations for the series were taken from 1932, the actual observation time (and therefore the possibility of recurrence) was greater than stated. In certain cases this difference is more than a year and thus the recently mentioned possibility of error is at least partly counterbalanced. — The question of importance is: How great is the theoretical possibility of recurrence in a patient who has been well a certain number of years (providing she lives sufficiently long)? As a basis for such a figure there have been used those cases, which after the subtraction of earlier deaths and recurrences, had been observed more than a certain number of years. The observation time for those now alive and well has been reckoned back from the end of 1931. With the number so obtained as a starting point, the frequency of recurrence after a definite period of health has been calculated from table VIII. The percentage gives, with reservation for the above mentioned errors (small

number of cases, lack of uniform period of observation etc.), a picture of the theoretical tendency to recurrence in cancer of the cervix after different numbers of years of health, as shown in the material at the Radiumhemmet.

Table IX *

Tendency to recurrence after different numbers of years of cure in the five-year cases.

Number of cases	Years symptom free	Number of late recurrences	% of recurrences
222	> 5	27	12.2
211	> 6	18	8.5
182	> 7	13	7.1
141	> 8	8	5.7
117	> 9	6	5.1
88	>10	4	4.5
67	>11	2	3.0
43	>12	1	2.3
27	>13	0	0
18	>14	0	0
12	>15	0	0
10	>16	0	0
4	>17	0	0

* Table IX is intended to read as follows: Out of 222 cases alive and symptom free more than 5 years there were later on 27 recurrences = 12.2 % etc.

Case Histories[1]

1. M. J. 178/1914. 69 years. Stage IV. Large bulky tumor of the cervix, diffuse induration of the parametria, metastasis the size of a pea in the mucous membrane of the rectum. Pathological report on biopsy: malignant tumor with solid epithelial proliferation. Death after 18½ years (at 87). During the last years repeated cerebral hemorrhages, cause of death according to the doctor was severe nephrosclerosis + cerebral hemorrhages, no sign of uterine disease or cancer metastases. Last examination at the Radiumhemmet 4 years before death. No autopsy.
2. H. A. 259/1914. 44 years. Stage III. Large crater. Nodular involvement of both parametria with absolute fixation of the uterus. Pathological report on biopsy: squamous cell cancer. Death after 5 years 8 months. According to a letter, she was still free from uterine symptoms but had »throat catarrh and fever». Cause of death according to death certificate was lung and laryngeal tuberculosis. Last examination at the Radiumhemmet 1 year and 7 months before death. No autopsy.
3. A. M. 276/1914. 47 years. Stage III. Large bulky partially ulcerated cervical tumor with invasion of the whole anterior vaginal wall; in each parametrium a fixed nodule the size of a hazelnut. Biopsy not performed. After about 1 year a very suspicious resistance was felt at one pelvic wall. The parametrium was opened by a perineal section, a biopsy was taken and radium was applied in the bottom of the wound. Microscopic examination showed that cancer was not present. Resultant recto-vaginal fistula which never healed. Died in hospital with acute peri-

[1] All statements as to time are calculated from the first treatment.

tonitis after 9 years and 8 months. Last examination at the Radiumhemmet 4 months before death. No autopsy.

4. J. K. 215/1915. 54 years. Stage III. Large nodular cervical tumor, massive invasion of the left parametrium. Pathology report on biopsy: squamous cell cancer. Death after 6 years 6 months. Heart trouble in the last years; organic disease of the heart diagnosed by a doctor. Cause of death: paralysis of the heart. Last examination at the Radiumhemmet 2 months before death. No autopsy.
5. J. V. L. 242/1915. 56 years. Stage III. Cauliflower growth, the size of a hen's egg; nodular infiltration of the right parametrium. Pathology report on biopsy: squamous cell cancer. Death after $9^1/_2$ years. Last 6 years severe diabetes. Death in hospital. Cause of death as determined by autopsy: diabetes. Last examination at the Radiumhemmet 1 year and 2 months before death.
6. K. V. 270/1915. 57 years. Stage III. Craterlike ulcer; left parametrium entirely involved. Pathology report on biopsy: squamous cell cancer. Death after 15 years 8 months. Under medical observation for the last year because of repeated heart attacks. Cause of death: heart disease. Last examination at the Radiumhemmet 9 years before death. Afterwards regular correspondence from the patient's daughter. No autopsy.
7. A. L. L. 273/1915. 41 years. Stage II. Crater with tumor infiltration of the adjacent part of the left parametrium. Pathology report on biopsy: Squamous cell cancer. Death after 12 years 3 months without previous illness. Cause of death according to death certificate: probably paralysis of the heart. No uterine symptoms. Was a chronic alcoholic. Last examination at the Radiumhemmet 5 years before death. Last communication 11 months before death. No autopsy.
8. M. A. 62/1918. 48 years. Stage III. Large disc-shaped tumor extending over the anterior vaginal wall to $3^1/_2$ cm. from the urethra, immovable, extending to but not invading the left pelvic wall. Pathology report on biopsy: cancer. Death after 11 years 9 months from diffuse bronchitis + bilateral bronchopneumonia. According to the doctor, no uterine symptoms. Last examination at the Radiumhemmet 8 years before death, last communication with the patient 9 months before death. No autopsy.
9. K. U. B. 530/1918. 61 years. Stage III. Large disc-shaped tumor reaching close to both pelvic walls and a nodular strand in the right sacro-uterine fold. Pathology report on biopsy: squamous cell cancer. Death after 13 years 5 months. In the last years marked difficulty in swallowing considered to be due to oesophageal cancer. Died in hospital from pneumonia and pulmonary tuberculosis according to the autopsy report. Accidental findings were stenosis of the oesophagus and calcified myomas of the uterus.
10. A. J. 344/1919. 55 years. Stage (III—)IV. Nodular cervical tumor involving the vaults. Tumor almost reached the right pelvic wall and was immovable there. At explorative laparotomy metastatic lymph nodes had been found in the pelvis. Pathology report on biopsy: squamous cell cancer. Death after 12 years 7 months from chronic myocarditis and chronic bronchitis according to the doctor. Last examination at the Radiumhemmet 1 year and 3 months before death. At last communication 3 months before death patient had tracheal catarrh. No autopsy.
11. H. R. 385/1919. 44 years. Stage III. Large disc-shaped tumor with crater formation. Massive invasion of the left parametrium. Pathology report on biopsy: squamous cell cancer. Death in hospital after 11 years and 9 months with a decompensating heart. Had then had heart trouble for more than 8 years. Last examination at the Radiumhemmet 8 months before death. No autopsy.

12. A. L. 404/1919. 52 years. Stage III. Huge crater involving almost the whole vagina. Parametria free. Pathology report on biopsy: squamous cell cancer. Death after 6 years 2 months from heart failure without a sign of recurrence according to the doctor, who had treated her for many years for severe organic disease of the hearth. Last examination at the Radiumhemmet 1 year and 4 months before death. No autopsy.
13. A. H. 485/1919. 66 years. Stage III. Whole cervix friable, superficial tumor infiltration down half the anterior vaginal wall. Pathology report on biopsy: papillomatous squamous cell cancer. Death after 8 years 9 months from pyelonephritis, thrombophlebitis and multiple lung abscesses according to autopsy. No cancer found at microscopic examination of organs including uterus and pelvic lymph nodes.
14. A. O. 578/1919. 47 years. Stage III. Disc-shaped tumor with massive infiltration of the left parametrium. Pathology report on biopsy: squamous cell cancer. Death after 6 years and 6 months. Since last treatment a clinically suspicious but completely stationary nodule had been observed at the left pelvic wall. Acute illness and death from agranulocytic angina (clinical and autopsy diagnosis). Uterus and nodule at the left pelvic wall showed no cancer on microscopic examination. In the pouch of Douglas a small nodule containing some necrotic unidentifiable cell remnants.
15. E. K. F. 243/1920. 62 years. Stage II. Crater involving the top of the vagina. Pathology report on biopsy: squamous cell cancer. Death after 8 years 2 months from arteriosclerosis, according to the death certificate. 3 years before death had had a cerebral hemorrhage and since that time dizziness etc. Last examination at the Radiumhemmet 3 years before death, after that repeated telephone communications, the last one taking place 6 months before death. No autopsy.
16. E. K. 561/1920. 56 years. Stage I. Half mandarin-sized swelling of the anterior lip of the cervix. Pathology report on biopsy: papillomatous squamous cell cancer. Death after 7 years 6 months from influenzal pneumonia (1 week's illness during an epidemic). Last examination at the Radiumhemmet 8 months before death. No autopsy.
17. K. N. 94/1921. 58 years. Stage III. Crater with a border as thick as a finger, massive invasion of the parametrium. Pathology report on biopsy: squamous cell cancer. Death after 9 years from diabetes and articular rheumatism. Could never come to the Radiumhemmet for examination on account of this rheumatism. Followed by means of regular correspondence. No autopsy.
18. M. K. 169/1921. 57 years. Stage II. Scattered nodules on and around the cervix. Pathology report on biopsy: cancer. Death after 7 years. Patient was treated in 1920 at the Radiumhemmet for a lymphosarcoma in the nose. The cause of death was probably cerebral arteriosclerosis. Patient treated the last years for mental disease in a home for the aged. According to numerous letters had never symptoms of uterine disease, metastases or recurrence of the nose tumor. No autopsy.
19. H. M. 455/1921. 62 years. Stage I. Endocervical cancer without enlargement of the cervix. Pathology report on biopsy: partly papillomatous cancer, probably of squamous epithelial nature. Death in hospital after 10 years 3 months from lung embolus following an accidental fracture of the neck of the femur. Pelvic organs not examined at autopsy. Last examination at the Radiumhemmet 1 year 3 months before death. Last communication from patient 10 months before death.
20. C. A. L. 17/1922. 50 years. Stage III (—IV). Large crater. Massive invasion of the right parametrium; on the left, tumor absolutely immovable but rounded off at the

pelvic wall. Pathology report on biopsy: squamous cell cancer. Death after 9 years 11 months from cerebral embolus and organic heart disease. No cancer was found on gross and microscopic examination of the uterus and pelvic lymph nodes.

21. A. W. 175/1922. 47 years. Stage II. Crater. Tumor infiltration of the left parametrium up to half a finger-breadth from the pelvic wall. Pathology report on biopsy: squamous cell cancer. Death after 9 years 11 months. Examined the day before death by a surgeon who found acute throat infection with cervical lymphadenitis. Sudden death from glottis edema. Last examination at the Radiumhemmet 1 month before death. No autopsy.
22. S. E. E. 543/1922. 71 years. Stage I. In another hospital a walnut-sized endocervical polyp removed by tortion, at the Radiumhemmet no pathological finding. Pathology report: fibromyoma with cancroid degeneration. Death after 7 years 11 months. Autopsy report: severe arteriosclerosis with myocarditis, no abnormality of the genitalia. Last examination at the Radiumhemmet 10 months before death.
23. K. A. 350/1923. 57 years. Stage II. Crater involving the vaults. Pathology report on biopsy: squamous cell cancer of the basal cell type. Death after 7 years 9 months from lung embolus following accidental pelvic fracture. At autopsy the genital organs were not examined. Last observation at the Radiumhemmet 4 months before death.
24. A. H. 905/1924. 55 years. Stage III (—IV) Enormous crater in the upper half of the vagina, tumor absolutely immovable against both pelvic walls but rounded towards them. Pathology report on biopsy: squamous cell cancer. Death after 5 years 7 months from chronic bronchitis and organic heart disease. Had had for 3 years severe heart symptoms, such as anginal attacks with signs of lung edema. Last examination at the Radiumhemmet 9 months before death. Last communication from the doctor 2 months before death. No autopsy.

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25. M. L. S. 304/1914. 58 years. Stage III. Endocervical cauliflower-like tumor the size of a hen's egg. In the right parametrium a hard string as thick as a lead pencil, on the left the tumor reached the pelvic wall. Firmly fixed on both sides. Pathology report on biopsy: papillary adenocarcinoma. After $3^1/_2$ years pyometra; repeated radium and roentgen treatment given on suspicion of recurrence. Afterwards symptom free. After 5 years 4 months stomach symptoms. At laparotomy an inoperable circular definitely primary cancer of the pylorus was found; genitalia normal. Death after 6 years. No autopsy.
26. G. v. R. 36/1915. 58 years. Stage II. Cancer of the cervical stump (about 1902 a supravaginal hysterectomy for myoma). Disc-shaped tumor of the posterior cervical lip and adjacent vaginal wall. Pathology report on biopsy: cancroid carcinoma. After 6 years suspicious stomach symptoms. At laparotomy an inoperable cancer of the stomach was definitely diagnosed as primary by the surgeon; no abnormality of the genitalia. Death after 6 years 8 months. No autopsy.
27. A. Z. 158/1915. 49 years. Stage III. Disc-shaped tumor. Massive invasion of the medial parts of both parametria, nodular involvement of the lateral parts. No abnormality of rectum. Pathology report on biopsy: squamous cell cancer. After 14 years an inoperable rectal cancer of the usual type was discovered, and colostomy was done. The diagnosis was made both by us and the experienced surgeon to whom the patient was referred. Death after 14 years 7 months. No autopsy.
28. S. D. 583/1920. 38 years. Stage II. Mushroom-like tumor extending into the vaults and infiltrating the adjacent part of the right parametrium. Pathology report on

biopsy: squamous cell cancer. After 6 years, loss of weight and difficulty in breathing. Death after 7 years. At autopsy a primary squamous cell bronchiogenic cancer was found in the right lung. Microscopic examination of the genitalia showed no abnormality.

29. H. V. 405/1921. 43 years. Stage II. Walnut-sized tumor on the posterior lip of the cervix involving the vault. Pathology report on biopsy: squamous cell cancer. After 8 years 3 months pain and loss of weight. A fist-sized tumor was found in the anterior vaginal wall and the right side of the pelvis. Pathology report on biopsy: polymorphous round-cell sarcoma. Patient received repeated roentgen treatments; the tumor diminished rapidly and recurred quickly after each series. Gradually large tumors developed in the epigastrium and left iliac fossa. Death after 9 years 6 months. No autopsy.
30. K. B. 330/1922. 55 years. Stage II. Large cauliflower-like tumor involving the vaults. Pathology report on biopsy: papillomatous squamous cell cancer. After $9^1/_2$ years difficulty in swallowing. Death after 9 years 8 months. At autopsy an oesophageal cancer was found, definitely primary. Microscopic examination of the uterus showed no cancer.

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31. A. M. M. 293/1915. 61 years. Stage III (—IV) Cauliflower-like tumor with crater-formation; tumor involving the entire right parametrium and practically reaching the left pelvic wall. Pathology report on biopsy: squamous cell cancer. Death after 5 years 8 months from cancer, according to the death certificate. At the last examination at the Radiumhemmet 7 months after treatment she still had lymph nodes at the pelvic walls. According to later communication, well and able to do strenuous work. No details known as to the cause of death.
32. E. S. 279/1916. 60 years. Stage III. Endocervical crater with involvement of the vaults. In the left parametrium nodules as far out as the pelvic wall. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After $6^1/_2$ years swelling of the leg and an indefinite mass could be palpated in the right iliac fossa. Genital organs apparently normal. Death after 8 years and 5 months with hemiplegia. No autopsy.
33. J. D. 284/1916. 59 years. Stage II. Nodular tumor of the cervix involving the vaults. Medial portion of left parametrium nodular and thickened. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 5 years and 7 months vague abdominal symptoms, fever and diarrhoea. Normal condition of pelvic organs. Death after 5 years 10 months. At autopsy a large friable cancerous cavity was found in the left retroperitoneal region. Microscopically no cancer in the uterus.
34. E. H. B. 329/1916. 59 years. Stage III. Endocervical cancer. Both parametria diffusely nodular and some fixation of the uterus. Pathology report on biopsy: rather highly differentiated adenocarcinoma. New radium and roentgen treatments were given after 2 years when some suspicious nodules were discovered on the outside of the cervix. The finding remained unchanged year after year. The same condition at the end of 5 years except that the cervix was possibly somewhat firmer than normal. In 5 years and 4 months a biopsy was taken from the cervix and diagnosed adenocarcinoma. Vaginal radium treatment. Shortly afterwards a large tumor to the left of the uterus was discovered. It seemed to be an ovarian tumor and disappeared slowly after roentgen treatment. After 6 years 4 months a left sided mammary cancer appeared, which was treated by electro-coagulation and roentgen and never recurred. Pathology report on biopsy: scirrhous cancer of the mammary

type, not resembling the uterine cancer. After 7 years no obvious signs of cancer in the pelvis. After 7½ years a recurrence in the cervix gradually spreading into the vagina; ultimately skin metastases over the lower abdomen. Death after 8 years 10 months. No autopsy.

35. V. N. 170/1917. 52 years. Stage III. Nodular and ulcerating tumor of the cervix with a string of nodules the thickness of a little finger in the right parametrium, extending out to the pelvic wall. Pathology report on biopsy: undoubtedly squamous cell cancer. Well at end of 5 years. After 10 years swelling of the leg and pain. No change in the cervix, enlargement of the corpus uteri, metastases in the pelvic bones and in the femur. Repeated series of roentgen treatments. Death after 12 years. No autopsy.

36. K. J. 228/1917. 64 years. Stage II. Nodular, disc-shaped tumor involving the adjacent part of the vagina, diffuse thickening of the left parametrium with some fixation of the uterus. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 12 years 9 months discharge from the vagina. Corpus uteri enlarged. Death after 13 years 5 months. At autopsy the body of the uterus contained friable cancer masses (pathology report: squamous cell cancer). Pelvic lymph nodes free from cancer.

37. A. L. 509/1917. 38 years. Stage III. Disc-shaped tumor involving part of the vagina; on rectal examination a tumor the size of a goose egg extending to the right pelvic wall and nearly reaching the left. Pathology report on biopsy: squamous cell cancer. After 4 years 9 months swelling of left leg, diagnosed as a thrombosis. After 5 years, as the symptoms gradually increased a diffuse swelling appeared at the left pelvic wall and in the left iliac fossa. Death after 5 years 9 months. No autopsy.

38. E. S. 841/1918. 39 years. Stage II. Endocervical tumor, on rectal examination the size of a goose egg, left parametrium very short. Pathology report on biopsy: adenocarcinoma. Well at the end of 5 years. After 11 years blood-stained discharge. Total hysterectomy. No metastases in the pelvic lymph nodes. In the uterus there was cancer of the same type as before. After the operation a suspicious swelling was felt at the pelvic wall which decreased following teleradium treatment. Death after 11 years 7 months with epileptiform attacks and hemiplegia (brain metastases?). No autopsy.

39. K. J. 276/1919. 53 years. Stage III. Large crater in the upper half of the vagina with infiltration of the medial part of the right parametrium. Pathology report on biopsy: squamous cell cancer. After 1 year a small recurrence on the urethral prominence. Pathology report on biopsy: cancer. The metastasis disappeared following local radium treatment. After 1 year and 4 months large lymph node mass in right inguinal region, clinically unmistakably metastatic: it disappeared after an insignificant roentgen dose given purely as a palliative. After 3½ years a new recurrence on the urethral prominence. (Biopsy: cancer.) After repeated roentgen and radium treatment again symptom free. Well at the end of 5 years. After 8½ years swelling and pain in the left leg and diffuse swelling on the left side above Poupart's ligament. Death after 9 years 5 months. No autopsy.

40. E. D. 520/1919. 65 years. Stage III(—IV). Cervical cancer with extensive involvement of the vagina as far down as to the urethral prominence; on rectal examination a tumor the size of a hen's egg was felt spreading on to the left pelvic wall. In the right sacro-uterine fold a firm elastic cord. Pathology report on biopsy: squamous cell cancer. After 1 year 8 months a slowly growing superficial cancer in the vagina (pathology report: cancer). Did not come for treatment until the end of 4½ years. The cancer disappeared quickly following the repeated application of radium. At

the end of 5 years the patient had a superficial ulcer in the inlet of the vagina, which was clinically considered to be a radium necrosis. At the end of 5 years 4 months the condition was just the same i. e. not like cancer. According to the physician in charge the patient later showed both a radium necrosis in the vulva and a recurrence in the vagina. Finally generalized carcinoma with metastases in the inguinal regions, brain etc. Death after 6 years 2 months.

41. H. S. 205/1920. 43 years. Stage II. Crater with extension in the vaults, medial portion of right parametrium infiltrated. Pathology report on biopsy: squamous cell cancer. After $3^1/_2$ years pain in the right leg, not of cancer type. Normal condition on examination. Roentgenograms showed no destruction of the pelvic bones. Condition the same at the end of 5 years. After about $5^1/_4$ years the diagnosis was clear, the pain increased and the general condition became worse. Death after 6 years 4 months. No uterine haemorrhage or discharge. No autopsy.

42. A. K. 258/1920. 47 years. Stage I. Superficially ulcerated, partially endocervical tumor. Pathology report on biopsy: squamous cell cancer. After 1 year a small suspicious nodule appeared at the left pelvic wall. It remained unchanged from year to year and was still so at the end of 5 years. After $7^1/_2$ years swelling and pain in the right leg. Roentgenograms (after 8 years) showed a tumor encircling the right ureter and hydronephrosis. Death after 8 years 10 months. No autopsy.

43. K. B. 385/1920. 65 years. Stage III. Disc-shaped tumor infiltrating the left parametrium to the pelvic wall and adherent to a fixed group of lymph nodes the size of a walnut. Infiltration of the medial part of the right parametrium. Pathology report on biopsy: papillary squamous cell cancer. Patient did not return after the first treatment, which therefore could not be continued. At the end of 5 years alive and well according to a letter. After 7 years pain in the right leg. Death after 8 years 7 months. Blood-stained discharge during the last weeks. No autopsy.

44. A. R. V. 107/1921. 32 years. Stage I. Chiefly endocervical tumor with disfiguration of the vaginal portion of the cervix. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 8 years 10 months a superficial recurrence in the vagina. Pathology report on biopsy: cancer of the same type as before. The recurrence disappeared after application of radium. Still alive and symptom free. Last examination after 11 years 10 months.

45. H. A. 203/1921. 43 years. Stage II. Disc-shaped tumor involving the vaults, parametria very short but apparently not carcinomatous. Pathology report on biopsy: squamous cell cancer. Well at the end of 5 years. After 6 years swelling and pain in left leg, large metastatic nodule situated in the region of the left lower iliac nodes and towards the symphysis. Death after 7 years 10 months. No autopsy.

46. J. E. A. 230/1921. 48 years. Stage III. Large nodular cervical tumor, massive invasion of the right parametrium and some invasion of the left; myoma the size of a child's head. Pathology report on biopsy: squamous cell cancer. After one year a severe radium reaction and the appearance of a rectal fistula. At the end of 5 years well except for the rectal fistula. After 9 years 4 months pain in the epigastrium and a large liver tumor. No change in condition of pelvic organs. Death after 9 years 6 months. No autopsy.

47. H. v. S. 410/1921. 69 years. Stage II (—III). Crater extending on to vagina. On right, tumor almost reaches the pelvic wall and is immovable there, on the left, invasion of the medial part of the parametrium. Pathology report on biopsy: squamous cell cancer. After 4 years 4 months operated on for hemorrhagic mastitis. Pathology report: papillary cystadenoma, possibly a precancerous lesion. Well at end of 5 years. After $7^1/_2$ years discharge and back-ache, in the upper part of the

vagina a large recurrence extending out to both pelvic walls. Death after 8 years 4 months. No autopsy.

48. J. P. 425/1921. 54 years. Stage II. Disc-shaped tumor with crater formation extending in the vaults. At the left pelvic wall a small nodule (lymph node?). Pathology report on biopsy: papillomatous cancer, probably of squamous epithelial type. After a year a suspicious mass at the right pelvic wall, which remained unchanged. After 9 years pain in the back and legs. Roentgenograms showed metastases in the sacrum, pelvic bones, femur and tibia. Death after 9 years 2 months. At autopsy there was found to the left in the upper pelvis a centrally broken down fist-sized tumor mass, which had largely destroyed the pelvic bone. One para-aortic node was cancerous. No cancer in the uterus or adjacent parametria. The swelling on the right was not especially examined.

49. H. J. Ö. 18/1922. 57 years. Stage III. Nodular tumor of the cervix spreading to the vagina and massive infiltration of the right parametrium. Pathology report on biopsy: papillomatous squamous cell cancer. Well at end of 5 years. After 10 years 10 months a slight recurrence in the upper part of the vagina. (Pathology report: squamous cell cancer.) No subjective symptoms. New radium treatment. Alive.

50. N. V. K. 146/1922. 46 years. Stage II. Nodular and ulcerated cervical tumor with encroachment on the vagina. No biopsy taken on account of hemorrhage. During the years after treatment the findings were always uncertain, the cervix slightly firmer than normal, and the vagina close to the urethral prominence slightly uneven. After 6 years a small tumor plaque in the vagina (pathology report on biopsy: squamous cell cancer) as well as lymph node metastases at the right pelvic wall. During the following year extensive vaginal metastases appeared and a cervical tumor and finally metastases in the left supraclavicular fossa. Death after 8 years 10 months. No autopsy.

51. A. K. 213/1923. 51 years. Stage II. Ulcerating enlarged cervix, involvement of the vaults and the medial part of the left parametrium. Pathology report on biopsy: squamous cell cancer. The patient did not return for $^1/_2$ year after the first treatment. At that time the tumor had disappeared and no more treatment was given. Well at end of 5 years. After 6 years cough and loss of weight. Death after 7 years 3 months. Autopsy showed multiple lung metastases as well as smaller cancer nodules in the kidneys. Normal condition of genital organs.

52. A. N. P. 416/1923. 49 years. Stage II. Disc-shaped tumor involving part of the vagina, on rectal examination a tumor the size of a billiard ball pressing aside but not definitely infiltrating the parametria. Pathology report on biopsy: papillomatous squamous cell cancer. After about $2^1/_2$ years extremely suspicious nodule in vagina and swelling at the left pelvic wall. After radium and roentgen treatment the vaginal nodule disappeared, a little swelling to the left remained but gradually became softer and less suspicious. After $5^1/_2$ years pain in the left gluteal region and general condition worse, a large nodular mass at the left pelvic wall. Death after 6 years 5 months. No autopsy.

53. S. M. M. 477/1923. 34 years. Stage I. Snout-like tumor. Pathology report on biopsy: squamous cell cancer. After a year, out of a slowly receding radium reaction a slightly suspicious swelling at the left pelvic wall could be noticed. It remained unchanged from year to year. Condition the same at the end of 5 years. After 7 years pain in the left leg. After 7 years 8 months large tumor at the left pelvic wall. Death after 8 years 3 months. No autopsy.

54. M. N. 454/1924. 49 years. Stage II (—III) Disc-shaped tumor encroaching on the vagina, on rectal examination a tumor the size of a goose egg fixed to both pelvic walls but less firm laterally. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 7 years 10 months a cancer nodule was discovered at the urethral prominence and a hard nodular swelling at the right pelvic wall. No subjective symptoms. The vaginal nodule disappeared with teleradium amd roentgen treatment but the swelling remained. Still alive.

55. J. E. A. 660/1924. 64 years. Stage I. Cervix hard and slightly irregular. Pathology report on biopsy: squamous cell cancer. After treatment a nodule remained on the cervix and a thickening in the parametrium, unchanged from year to year. At the end of 5 years unchanged. After 5 years 8 months a cervical tumor the size of a hen's egg with nodular extension to the left pelvic wall, no subjective symptoms. Death after 7 years. No autopsy.

56. I. J. 675/1924. 45 years. Stage II. Disc-shaped tumor involving the vaults, both parametria infiltrated medially. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 5 years 8 months slight bleeding, otherwise no objective pathological findings, nothing obtained on curettage but the cavity of the uterus was felt to be irregular. On this account an intrauterine radium treatment was given. After 6 years metastasis at the urethral prominence which healed on intubation. After $6^1/_2$ years very suspicious swelling at the left pelvic wall. After 7 years definite cancer in both sides of the pelvis, and later involvement of the bladder. Death in 7 years 9 months. At autopsy there was found in the pelvis minor a large tumor mass which formed a central cavity into which the ureters, bladder and vagina opened. Destruction of bone on the right side of the pelvis. Bilateral hydronephrosis.

57. E. P. 773/1924. 42 years. Stage I. Hard nodule on the cervix. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 7 years a leukoplakia-like area in the vagina, which healed on the application of radium. After 7 years 4 months swelling of the left leg, a nodular mass at the left pelvic wall and large metastases in the left inguinal region. Death after 8 years 2 months. No autopsy.

58. A. K. P. 269/1917. 57 years. Stage III. Disc-shaped tumor largely involving the vagina, massive invasion of the right parametrium, nodules in the left parametrium. Pathology report on biopsy: squamous cell cancer. Well at end of 5 years. After 6 years pain and swelling of both legs, palpable thromboses in the veins of the legs, cardiac arhythmia. The symptoms disappeared spontaneously. After 7 years, gradual loss of weight until 3 years before death and then more rapid loss of weight. Death after 13 years 8 months with increasing cachexia and pains in lumbar regions. At last examination in the Radiumhemmet 3 months before death no objective symptoms except loss of weight. Roentgen examination one month before death showed no abnormality of the lungs, vertebral column or pelvis. No local symptoms ever appeared which could help with the diagnosis. No autopsy.

59. E. J. 447/1923. 46 years. Stage III. Small crater, large nodules in both parametria almost up to the pelvic walls, immobilisation of the uterus. Pathology report on biopsy: squamous cell cancer. After 10 months a large rectovaginal and vesicovaginal fistula, the surrounding tissue converted to dense scar tissue. After $1^1/_2$ years swelling of both legs and occasional mild pain. At end of 5 years condition unchanged. Death after 6 years 5 months. Last 2 months (according to observations of the patient's daughter) large ecchymoses on the legs, bleeding from the intestine, gradually developing faecal vomiting and intestinal obstruction, finally the whole body up to the waist line turned a blue color. No autopsy. Last examination at the Radiumhemmet 8 months before death.

SUMMARY

This study is based on 1016 cases of cancer of the cervix radiologically treated at the Radiumhemmet from 1914 to 1925 inclusive, 222 of which were five-year cures. In 1932, of these 222 cases 163 were alive, without having had a recurrence. The remaining 59 cases may be subdivided as follows: 24 deaths without any sign of cancer (i. e. »cancer free»), 6 deaths from intercurrent cancer, 27 recurrences and 2 deaths from uncertain causes.

There were 12.2 % recurrences after an observation time of 7 to 18 years and 15.5 % recurrences after an observation time of 10 to 18 years. The division of the cases of recurrence into different age groups at the time of the first treatment agrees with the division of the total cervical cancer material. No relation exists between tendency to late recurrence and the anatomical type of the tumor. There is the same frequency of late recurrences in the early and the more advanced cases. »Cancer free» deaths occur proportionally more often in the more advanced cases.

With regard to their localization the recurrences may be divided as follows: 6 in the cervix and adjacent portion of the vagina, 2 in the corpus uteri, 10 in the connective tissue and lymph node areas of the pelvis, 2 distant recurrences, 5 cases where the original location of the recurrence was impossible to determine and 2 cases where the localization was not known.

9 recurrences were manifested in the 6th year, 5 in each of the 7th and 8th years, 2 in each of the 9th, 10th and 11th years and 1 in each of the 12th and 13th years. Out of the 4 recurrences in the 11th year or later, 3 were definitely and a fourth probably situated in the uterus and close to it.

Finally an attempt is made to state the risk of late recurrence according to the different number of years of cure.

ZUSAMMENFASSUNG

Die vorliegende Arbeit gründet sich auf 1016, in den Jahren 1914 bis einschliesslich 1925 am Radiumhemmet radiologisch behandelte Fälle von Zervixkarzinom, von welchen 222 5-Jahres-Heilung erreichten. Im Jahre 1932 waren von diesen 222 Fällen 163 am Leben und rezidivfrei geblieben. Die übrigen 59 Fälle verteilen sich folgendermassen: 24 Todesfälle ohne Zeichen von Karzinom (d. h. »karzinomfrei»), 6 Todesfälle an interkurrentem Karzinom, 27 Rezidiven und 2 Todesfälle aus unsicherer Ursache.

12.2 % Rezidiven traten nach einer Beobachtungszeit von 7 bis 18 Jahren auf, und 15.5 % Rezidiven nach einer Beobachtungszeit von 10 bis 18 Jahren. Die Verteilung der Rezidivfälle auf verschiedene Altersgruppen zur Zeit der ersten Behandlung stimmt mit der Verteilung des gesamten Zervixkarzinommaterials überein. Zwischen Tendenz zu Spätrezidiv und dem anatomischen Typus des Tumors besteht keine Beziehung. Frequenz von Spätrezidiven in frühen und vorgeschritteneren Fällen ist gleich gross. »Karzinomfreie» Todesfälle kommen bei den vorgeschritteneren Fällen verhältnismässig häufiger vor.

In Bezug auf ihre Lokalisation können die Rezidiven folgendermassen eingeteilt werden: 6 im Zervix und dem angrenzenden Teile der Vagina, 2 im Corpus uteri, 10 im Bindegewebe und in den Lymphdrüsengebieten des Beckens, 2 Fernrezidiven, 5 Fälle, wo die ursprüngliche Lokalisation des Rezidivs nicht bestimmbar war, und 2 Fälle mit unbekannter Lokalisation.

9 Rezidiven wurden im 6. Jahre manifest, je 5 im 7. und 8. Jahre, je 2 im 9., 10. und 11. Jahre und je 1 im 12. und 13. Jahre. Von den 4 im 11. Jahre oder später aufgetre-

tenen Rezidiven waren 3 sicher und ein viertes wahrscheinlich im Uterus und seiner nächsten Nachbarschaft gelegen.

Schliesslich versucht Verf., die Gefahr des Auftretens eines Spätrezidivs nach der verschiedenen Zahl der Heilungsjahre festzustellen.

RÉSUMÉ

La présente étude est basée sur 1016 cas de cancer du col utérin radiologiquement traités au Radiumhemmet de 1914 à 1925 inclusivement, dont 222 représentaient un guérison après 5 ans. De ces 222 cas, 163 survivaient en 1932 sans avoir eu récidive. Les 59 autres cas peuvent être groupés de la façon suivante: 24 morts sans signes de cancer (c. à d. »exempts de cancer»), 6 morts par cancer intercurrent, 27 récidives et 2 morts de cause douteuse.

On a noté 12.2 % de récidive après une durée d'observation de 7 à 18 ans, et 15.5 % de récidives après une durée d'observation de 10 à 18 ans. La division des cas de récidive suivant les divers groupes d'âge à l'époque du premier traitement concorde avec la division du matériel total de cancer du col utérin. Il n'existe aucune relation entre la tendance à une récidive tardive et le type anatomique de la tumeur. Les récidives tardives sont aussi fréquentes dans les cas récents et dans les cas plus avancés. La mort »exempte de cancer» survient proportionellement plus souvent dans les cas plus avancés.

En ce qui concerne le siège des récidives, celles-ci se divise de la façon suivante: 6 dans le col et la portion adjacente du vagin; 2 dans le corps; 10 dans le tissu conjonctif et les régions ganglionnaires du bassin; 2 récidives à distance; 5 cas où il n'était pas possible de localiser l'origine de la récidive et 2 cas de localisation inconnue.

Neuf récidives survinrent dans la sixième année; 5 dans chacune des septième et huitième années, 2 dans chacune des neuvième, dixième et onzième années, et 1 dans chacune des douzième et treizième années. Des 4 récidives survenues au cours de la onzième année ou plus tard, 3 étaient certainement et 1 probablement situées dans l'uterus et à proximité de l'organe.

Enfin, l'auteur cherche à établir les risques de récidives tardives suivant les durées diverses de la guérison.

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ON PROTECTION AGAINST RADIATION IN TELERADIUM TREATMENT[1]

by

Rolf M. Sievert

It is very difficult to decide what protection may be needed for doctors and nurses engaged in giving teleradium treatment. Our knowledge of the effects of exposure of the whole body to weak but lengthy gamma radiation is very imperfect, and practical experience of the risks of teleradium treatment still covers a relatively brief period. The influence of the time or intensity factor at weak radiation intensities is another question which has not yet been settled. Our knowledge regarding individual variations of sensitivity to radium in small doses is equally slight.

There are two points of view from which protection against gamma radiation can be discussed. One is the assumption, analogous with experience from X-ray therapy, of a certain tolerance dose which, taking into account the greater penetration of the gamma rays, is computed from that which by some authors (MUTSCHELLER, Journal of Roentgenol., 13, p. 65, 1925) has been considered most probable, viz. 1/10 HED, i. e. 30 to 70 r per annum. BENNER (Acta Radiol. 11, p. 310, 1931), who has measured the radiation intensity in the rooms adjoining the present Radiumhemmet treatment rooms (3 gms of radium element), has found that doses of this magnitude are only attained in the rooms on the same floor as and immediately adjoining the treatment room, although the walls contain no special protective material.

The other point of view is that even very small quantities of radiation may have distinct biological effects.[2] From this latter point of view,

[1] Submitted for publication Oct. 26th, 1933.

[2] Investigations of the biological effects of very weak gamma radiation have lately been begun at the Radiumhemmet Physical Laboratory. Preliminary experiments have shown that a distinct effect can be demonstrated in certain biological objects after but a few days' exposure to radiation, even at radiation intensities corresponding to an ionisation in air of about $1 \cdot 10^3$ ions per cm^3 per sec., i. e. about 100 times the intensity commonly present owing to the radioactivity of the earth's crust.

satisfactory protection can only be obtained by providing teleradium rooms with protective walls heavy enough to absorb practically all radiation, even the hardest gamma radiation.

Comparison with the X-ray tolerance dose is very risky, for one thing because of the fundamentally different distribution in time of the radiation. While in a therapeutical X-ray establishment series of relatively short radiations are given only during part of the day, teleradium treatment must take into account a radiation which, though perhaps weaker, is constant and lasts both day and night. This is anyway the case when dealing with the radiations to which persons in adjoining rooms are exposed, without taking into account the occasional doses received by the staff during the application and adjustement of the teleradium apparatus. The results of investigations in recent years of fractional protracted radiation perhaps even support the assumption that a continuous, weak radiation of long duration involves considerably greater risk than short radiations, even if the latter are relatively intense. Finally, we must also consider the appreciable difference in the absorption of hard gamma rays and of X-rays obtained at a max. of 200 kV. For the hardest components of radium radiation, absorption in the tissues may be practically disregarded in view of the distribution of the secondary radiation (cf. GRIFFITH, Acta Radiol. p. 608 1933), whilst for Roentgen radiation at the voltage named the half-value layer is something like 10 cm.

In the present stage of medical radiology, and with the radium quantities used up to now (max. 3—10 gms), it might with some justice be maintained (cf. BENNER, *loc. cit.*) that protection is not absolutely essential in the floor, walls, and ceiling of the teleradium room, at least ..ot if the same persons do not occupy adjoining rooms the greater part of the day for years. Except in a new building, or in fitting up a treatment room situated in a basement, it is also in most cases technically almost impossible to provide quite effective protection.

But if a new hospital is to be built, and if we allow for the probability of still larger radium quantities (25—100 gms) being available in the future, matters become very different. In that case the provision of fully adequate protection would be justified, even at a relatively high cost.

As no less than three central radiological hospitals, all working with comparatively large quantities of radium, will be built in Sweden in the next few years, the question of protection in teleradium treatment is of great and immediate interest in this country.

The largest of these hospitals — the King Gustaf V Jubilee Clinic, which will be built for the Radiumhemmet — will have no less than 4 teleradium treatment rooms. For reasons of accessibility it was first intended to house the teleradium department on one of the central

floors. Later, the possibility was discussed of reducing the risk of the hospital staff being exposed to detrimental radiation, and it was then proposed to move the department to the top floor, and to make the floor and possibly also the walls of some suitable protective material. It was found, however, that even this would have considerable drawbacks in that, for instance, a sufficient quantity of protective material could not very well be put into the walls owing to the considerable weight involved. Insufficient protection would mean that if another floor were later added to the hospital, the use of the rooms adjoining the teleradium room would be restricted. In the final plan, the teleradium treatment rooms were therefore moved to the basement, the floor of which is about 2 m below the ground, the height of the room being 3 m.

A suitable protective material had then to be found. As far as the walls were concerned, this ought to have the following properties:

1) The material should have the highest possible mean density and be sufficiently homogeneous.

2) It should be sufficiently strong and durable for use in foundation walls.

3) The building costs should be as low as possible.

Iron ore concrete of suitable composition apparently complies fairly well with these demands. Ordinary concrete can of course be used, provided that there is enough space for the walls to be made sufficiently thick.

For the ceiling, which was anyway to be made from ferroconcrete, additional iron reinforcements were suggested, to make it strong enough to carry a filling of crushed iron ore.

Investigations of changes in the strength of concrete have proved that the presence of fairly small quantities of certain substances can in a relatively short time completely destroy the concrete. For this reason, and to find out what volume weight and strength could be obtained, the Cement Laboratory of the Academy of Engineering Research at Stockholm was asked to make certain tests. The report from the Laboratory is given *in extenso* below.

»Cement Laboratory. Academy of Engineering Research.

INVESTIGATION OF THE SUITABILITY OF USING IRON ORE IN THE MANUFACTURE OF HEAVY CONCRETE.

The following investigation of the suitability of using Swedish iron ore in the manufacture of heavy concrete has been made at the request of Mr. R. SIEVERT, D. Ph., of the Radiumhemmet Physical Laboratory. According to him, the object of this investigation was to ascertain whether, in the building of the Karoline Hospital, the costly lead lining could be dispensed with in rooms from which it must be possible to prevent outgoing radiation, and to let this be absorbed — instead of in lead — in the structural concrete

of the building which, given sufficient weight, need not be of inconveniently large dimensions.

I. *Selection of an iron ore of suitable grading.*

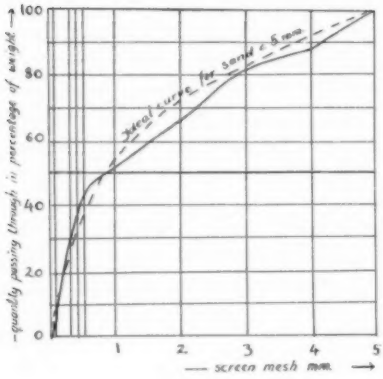

Fig. 1.

———— Grain distribution in iron ore sample.
- - - - - - - - Ideal curve.

It is essential to the strength of concrete that the sand and stones used in its preparation be suitably graded, i. e. of sizes which will pack as densely as possible. As in this case it is intended to substitute crushed iron ore for all sand and stones in the mixture, this crushed product must obviously be selected on the same principles as in mixing ordinary concrete. A crushing which conforms fairly well to the so called »ideal curve» drawn up for ordinary concrete is the only one which can be approved.

The schedule below describes the 5 different samples of iron ore submitted for examination, and refers for each material to separate Tables giving the grain sizes composing each material. (The sulphur content of the materials has not been ascertained, as Dr. SIEVERT will procure information on this point. Too high sulphur content, however, would render the material unfit for use in concrete owing to the risk of disintegrating gypsum forming.)

Sample No.		Size of grain given in:
1.	Crushed iron ore from Luossavaara-Kirunavaara	Table 1[1]
2.	D:o	» 2
3.	D:o, marked A-concentrate	» 3
4.	Crushed iron ore from Grängesberg	» 4
5.	Crushed iron ore from Luossavaara-Kirunavaara	» 5

These Tables immediately show that the samples Nos. 1 to 4 are all far too finely crushed, while the grain sizes of samples 5 are particularly suitable for use in concrete, a fact which is also indicated by the diagram above, where the grain size distribution in the crushed ore is compared to the ideal curve. (The diagram only refers to that part of the material which was less than 5 mm in size; the distribution of sizes in the coarser screens is, however, also suitable.)

II. *Strength tests.*

From the above ore sample No. 5, a concrete mixture was prepared consisting of one part of cement (by weight) to 9 parts of ore (in view of the difference in specific gravity, this corresponds to the ordinary concrete mixture of 1 : 2 : 3) and with a water-cement ratio = 0.52. Other data are given in the following schedule.

[1] These tables are not published here.

Age, days	Volume weight	Crushing stress, kgm/cm²
0	4.03	—
28	3.67	314, 310 } average 312

The concrete samples were kept 7 days covered by damp sacking, and after that uncovered in open air. The reduced volume weight is quite natural and due to the drying of the concrete.

The crushing stress is quite normal and satisfactory and, judging by the results so far obtained, there consequently seems to be no objection to the use of »ore concrete» of this kind. Before forming a definite opinion on this point, however, the results of the long-time tests now being made should be awaited.

III. *Other data.*

The iron ore of sample 5 has a specific gravity of 4.79, and a volume weight of 3.29 when loosely filled and 3.64 when closely packed.

The mass in a wall made of the ore concrete tested here, and about 40 cm thick, is equal to that of a lead layer 13 cm in thickness.

Finally, it should be observed that heavy concrete manufactured from Swedish iron ore has been used for counterweights in a bridge built at Washington. To increase the volume weight still more, scrap iron was also added there, which gave the concrete a volume weight of 4.34. This construction is described in Revue des Matériaux de Construction et de Travaux Publics 1932, 511.

Stockholm, April 5th 1933

Cementlaboratoriet

Donovan Werner. Stig Giertz-Hedström.

Stockholm, Sept. 5th 1933.

— — — The test results on »ore concrete» 6 months old, prepared in a manner analogous to the tests previously described, are:

Test No.	Age	Crushing stress, kgm/cm²
3	6 months	414, 432 } average 423
4	6 »	

As the crushing stress after 28 days was 312 kgm/cm², this has increased by 36 per cent., and the subsequent hardening may thus also be considered quite satisfactory. — — —

If we accept the principle that the protective walls of the teleradium room shall effectually screen all radiation, the small residue of hard gamma rays which penetrates them must be nearly of the same order of magnitude as that, of similar penetrating power, occurring in nature. This »natural radiation» can be demonstrated all over the surface of the ground, and has an average ionising power in air corresponding to 10 ions per cm³ per sec. at 0° and 760 mm Hg.

If M denote the radium content in gms. of the teleradium apparatus, a the distance from the radium to the point at which the radiation is

to be determined, and A the absorption factor — which depends on the amount of material between the radium and the point under consideration — then the ionisation may be approximately computed from the formula

$$n = \frac{4 \cdot 10^9}{a^2} \cdot M \cdot A \quad \ldots\ldots\ldots\ldots \quad (1)$$

The absorption factor is obtained from the formula

$$A = e^{-(\mu_1 d_1 + \mu_2 d_2 + \ldots)} \quad \ldots\ldots\ldots\ldots \quad (2)$$

where μ_1, μ_2, etc. are the absorption coefficients and d_1, d_2, etc. the thickness of the various materials.

When, as in this case, the absorbing layers are very thick, nothing but the hardest radiation will penetrate the wall, and no appreciable amount of secondary radiation from its deeper portions, which is on the whole considerably softer than the primary radiation, will be able to reach the surface of the wall. We can therefore use the absorption coefficients experimentally determined for the hardest gamma radiation from RaC, especially as the soft, secondary beta and gamma radiation coming from the outermost layers of the wall can hardly have anything but a relatively superficial effect on the body. The risks involved in radiation at these small intensities is almost entirely due to the total amount of radiation received by the body.

If we then only consider the hardest primary gamma radiation we find, as its absorption per gram of different materials is practically constant, that formula (2) changes into

$$A = e^{-0{,}047(\varrho_1 d_1 + \varrho_2 d_2 + \ldots)} \quad \ldots\ldots\ldots\ldots \quad (3)$$

where ϱ^1, ϱ^2, etc. are the volume weights of the respective materials. This formula thus allows of the absorption factor being computed directly from the volume weights. The constant in the formula is determined on the assumption that lead of a specific gravity of 11.3 has an absorption coefficient of about 0.53.

The absorption factor A may suitably be divided into two components: A_b, which refers to the protection in the teleradium bomb itself, and A_w, referring to the protection in walls, floor, or ceiling. In the teleradium apparatus at present in use at Radiumhemmet (cf. SIEVERT, Acta Radiol. 14, p. 197, 1933) the average protection may be put at 3 cm. of lead, i. e. the emergent radiation is reduced to about 1/5. If we assume that a teleradium apparatus of this design containing 10 gms of radium element is used, and calculate the intensity of radiation at a distance of $a = 3$ m, formula (1) becomes

$$n \simeq 10^5 \cdot A_w \quad \ldots\ldots\ldots\ldots \quad (4)$$

In Table 1 below, a few data, obtained by means of (4), are given for comparison of protective walls of lead, iron ore or iron ore concrete, and ordinary concrete.

Table 1

Distance $a = 3$ m.

10 gms of radium element and 3 cm of Pb protection in the teleradium bomb.

Material:		Pb	Fe_3O_4 or Fe_3O_4 concrete	Ordinary concrete
Volume weight		11.3	3.67	1.95
Half-value layer		1.3 cm	4.1 cm	7.7 cm
Thickness of layer required for reducing n to:	$n = 10$ (nat. radiation)	17.4 cm	54 cm	100 cm
	$n = 10^2$	13.1	40	75
	$n = 10^3$	8.7	27	50
	$n = 10^4$	4.35	13.5	25
	$n = 10^5$	0	0	0
Cost of walls per sq.m. at $n = 10^2$, in Sw. kronor, about		350—500	70—80 (concrete)[1]	20—30

When using quantities of radium appreciably larger than 10 gms, it must be presumed that the design of the teleradium apparatus will be changed in certain respects. Increased protection would thus be necessary to avoid too great a risk from the radiation when the apparatus is adjusted. If very large radium quantities (50—100 gms) were to be used, an increase of protection from say 3 cm of lead to 6 or 7 cm of lead equivalent might conceivably be found essential. This might be provided by using heavier protective material, e. g. wolfram or gold. The distance at which treatments are given would then probably also increase, and the difficulty of applying such protection would therefore be much less. The additional protection required by the use of larger radium quantities could therefore probably be applied to the bomb itself, and an increase of the thickness of the walls need therefore not be necessary.

The only remaining factor affecting the thickness of the protective walls is thus the distance (a) from the radium quantity to the points where any one person may remain for long periods.

Table 2 gives the wall thickness required for reducing, at various distances between the source of radiation and the point in question, the radiation intensity to certain magnitudes when using iron ore filling or iron ore concrete under the conditions stated above. In using the Table,

[1] Price per ton of Gällivare ore, delivered at Luleå, about 20: — Sw. kr. Transport by lighter, about Kr. 6: — per ton, unloading and transport at Stockholm about Kr. 4: 50 per ton, i. e. a total cost of about Kr. 30: — per ton.

Table 2

Protective material: Fe_3O_4 or Fe_3O_4-concrete.

In the teleradium apparatus: 10 gms of radium element and 3 cm of Pb protection, or 100 gms of radium element and 6 to 7 cm of Pb equivalent.

Ionisation, n:		10 (nat. radiation)	10^2	10^3	10^4	10^5
Amounting to 1000 r in		6 600 years	660 years	66 years	6.6 years	240 days
Thickness of layer required at a distance of:	a = 3 m . . .	54 cm	40 cm	27 cm	13.5 cm	0
	a = 5 » . . .	48 »	34 »	21 »	7.5 »	0
	a = 7 » . . .	44 »	30 »	17 »	3.6 »	0
	a = 10 » . . .	40 »	26 »	13 »	0	0
	a = 15 » . . .	35 »	21½ »	8.1 »	0	0
	a = 20 » . . .	32 »	18 »	4.8 »	0	0

due consideration should also be given to the fact that in most cases the rays will pass obliquely through the walls, which will appreciably lengthen their passage through the protective material.

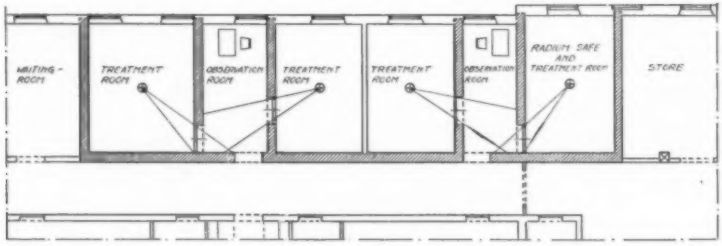

Fig. 2.

Fig. 2 gives the final plan of the new Radiumhemmet teleradium treatment department which, as has already been said, will be located in the basement. The shaded walls in the plan will be built of iron ore concrete of the kind described (sample 5 of the Cement Laboratory tests). Fig. 3 shows a section of the ceiling, filled with crushed iron ore. The mean distance from the radium to people working in the rooms above may be put at 4 to 5 metres, and the thickness of the filling is therefore fixed at 25 cm. This, and aproximately 25 cm. of ordinary reinforced concrete, will thus afford ample protection. No protective material will be required in the floor or outer walls.

The plan, Fig. 4, shows 4 teleradium rooms, each 5.80 (6.20) by 3.90 m (4.70) in size. Fixed teleradium instruments, in the main of the same design as that now in use at Radiumhemmet (cf. SIEVERT, *loc. cit.*), will

probably be installed in the middle of the rooms. For each pair of teleradium rooms, an anteroom is provided for the nurse centrally in, who has to look after the patients. The doors have been so placed, that while the nurse receives the best possible protection against gamma radiation, there is plenty of light and fresh air. The angle between the protective wall and the radiation directed on the table 9 in Fig. 2 is 50°—60°, and the effective protection will consequently be 45 to 50 cm of iron ore concrete. The doors are placed so that only a small part of the room is exposed to simultaneous radiation from both teleradium instruments.

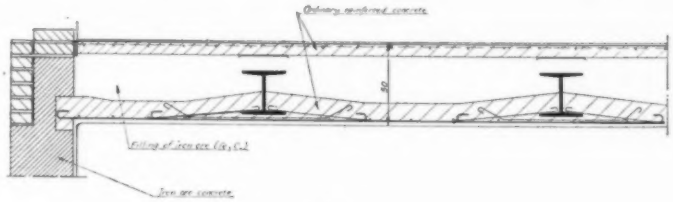

Fig. 3.

The difficulty of constructing doors giving effective protection against gamma radiation is considerable, and ordinary doors are therefore proposed, the casings of which are placed as far inside the treatment room as possible. This is done in order to give to any person sitting by the window maximum protection from exposure to secondary radiation from the doors. It might be advisable, however, to cover these doors with some protective material, e. g. sheet lead one or one and a half cm thick. But that protection would not stop more than about 50 per cent. of the radiation! Mirrors for observation of the patients should be fitted at the doors.

Table 2 on page 000 also gives some idea of the cost of the protective arrangements described here. In spite of the present unusually low price of lead, iron ore concrete should be 5 or 6 times cheaper than that metal, even excluding the cost of labour for putting up the lead protection. The cost of iron ore concrete will probably be about 3 or 4 times as much as of ordinary concrete. The total extra cost due to the provision of protective material as described here should not exceed 15,000 kr. for the whole teleradium department, which is a comparatively small sum in relation to the high costs of the whole teleradium equipment. The use of iron ore as a protective medium in premises intended for teleradium treatment thus seems to offer a chance of obtaining quite effective protection at a fairly moderate cost, without any necessity of appreciably exceeding the usual thicknesses of the walls.

SUMMARY

The author discusses the problem of protection in teleradium treatment, emphasizing that the question may be looked at from two different points of view. On the one hand, there is the experience from X-ray therapy, where doses not exceeding $^1/_{10}$ HED per annum are generally conceded to be innocuous. On the other hand, there is the fact that even very weak gamma radiation has been found to produce biological effects on certain objects.

The author considers that in the building of new premises for teleradium treatment the protection provided should be sufficient to ensure that the radiation penetrating into adjacent rooms should not appreciably exceed that which is normally present everywhere owing to the radioactivity of the earth's crust. For this reason the teleradium department should preferably be located in a basement, and the author suggests the use of concrete or — when great wall thickness is impracticable — iron ore concrete or iron ore filling. By the use of these materials, the thickness of the walls can be reduced to about 55 per cent. of that required in ordinary concrete, without anything like as high costs as when employing lead protection.

The author finally describes a teleradium department planned at Stockholm, and motivates the protective arrangements proposed there.

ZUSAMMENFASSUNG

Der Verfasser diskutiert das Problem des Schutzes bei Teleradiumbehandlung und weist gleichzeitig darauf hin, wie diese Frage von zwei verschiedenen Ausgangspunkten aus behandelt werden kann. Beim einen geht man von den Erfahrungen aus, die man in der Röntgentherapie gemacht hat; hier herrscht im Allgemeinen die Ansicht, dass Dosen von weniger als $^1/_{10}$ HED keine Schäden verursachen können. Der andere Ausgangspunkt dagegen stützt sich auf das Faktum, dass man auch bei sehr schwacher Gammabestrahlung an gewissen Objekten biologischen Wirkungen festgestellt hat.

Der Verfasser vertritt die Ansicht, dass bei einem Neubau von Teleradiumabteilungen für ausreichenden Strahlungsschutz gesorgt werden muss, so dass die Strahlung in der Umgebung derselben wenn möglich nicht nennenswert grösser ist, als die durch die Radioaktivität der Erdkruste erzeugte. Zu diesem Zwecke sollte die Teleradiumabteilung in eine Untergeschosswohnung verlegt werden, und schlägt der Verfasser als Wandmaterial in derselben Beton oder, wo sehr dicke Wände nicht errichtet werden können, Eisenerzbeton oder Eisenerzfüllung vor. Dieses Material gestattet es im Vergleich mit gewöhnlichem Beton die Wanddicke auf c:a 55 % herunterzubringen, wobei sich die Kosten nicht annähernd so hoch stellen, wie bei Bleischutzwänden.

Zum Schluss beschreibt der Verfasser eine in Stockholm geplante Teleradiumabteilung und begründet hierbei die daselbst vorgeschlagenen Anordnungen.

RÉSUMÉ

L'auteur discute le problème de la protection au traitement de téléradium et attire l'attention sur le fait que cette question peut être considérée de deux points de vue. L'un part des expériences faites dans la thérapie des rayons X, où, selon l'opinion générale, les doses inférieures à $^1/_{10}$ HED par an, ne sauraient causer de dommages. L'autre s'appuie sur le fait que des effets biologiques ont pu être constatés sur certains objets, même à un très faible rayonnement gamma.

L'auteur estime que, lors de la construction de sections de téléradium, il est nécessaire d'assurer une protection satisfaisante pour éviter si possible que le rayonnement dans les environs soit sensiblement plus fort que celui existant partout en raison de la radioactivité de la croûte terrestre. A cet effet la section de téléradium doit être installée de préférence dans un sous-sol, et l'auteur propose l'emploi de béton, ou, dans les cas où il ne convient pas que les murs aient une grande épaisseur, de béton contenant du minerai de fer ou d'un remplage au minerai de fer. L'emploi de ces matériaux permet de réduire l'épaisseur des murs à 55 % environ de celle que nécessite le béton ordinaire, sans que les frais soient à beaucoup près aussi élevés qu'avec l'emploi d'une protection au plomb.

Enfin l'auteur décrit une section de téléradium projetée à Stockholm et indique les motifs des dispositions proposées pour son aménagement.

FROM THE PHYSICAL LABORATORY OF RADIUMHEMMET, STOCKHOLM.
DIRECTOR: R. M. SIEVERT

A TEST OF SOME METHODS FOR CALCULATING DOSAGE IN RADIUM THERAPY[1]

by

Harry D. Griffith, Aberdeen.

Many difficulties, physical rather than mathematical, obstruct an attempt to calculate dosage in Radium Therapy, some arising from the shape of the sources used and from the effects of filtration on the incident radiation, and others from the modifications introduced by absorption and scatter in the body tissues. It is convenient to consider first the case of a source of radiation in air, and then to investigate how the distribution of radiation is altered when the air is replaced by a relatively dense material, containing no heavy atoms, such as water. A theoretical analysis of the gamma-ray intensity near linear sources of types commonly used in therapy has been given by SIEVERT (1) in which absorption in the radium salt itself, and in the walls of the filter, can be allowed for. Although there is some uncertainty as to the appropriate values of the absorption coefficients involved, these uncertainties do not greatly influence the results obtained. Some further cases have been subsequently analysed by the same method by MAYNEORD (2). In all calculations based on this method, secondary radiation from the filter must be ignored. This secondary radiation includes secondary β-rays (mainly photoelectrons) emitted from the filter and also secondary gamma radiation. Measurements by BENNER (3) have shown that the secondary β-radiation makes an important contribution to the total intensity at points within a few centimeters of the needle, in air. (The penetrating power of this radiation is limited to a millimeter or so in tissue.) The secondary γ-radiation originates partly from photo electric absorption of primary γ-rays in the filter: this part can only have a small fraction of the energy of the secondary β-rays. The rest of the secondary γ-radiation is excited by impact of primary β-rays on the filter, but this is so feeble that it is difficult to detect even in specially favorable circumstances (4).

[1] Submitted for publication Oct. 9th 1933.

When the radium needle is surrounded by a medium of appreciable density, but containing no heavy atoms, the nature of the radiation will be modified by Compton scattering, which will tend to make it become progressively softer as the proportion of »modified» radiation increases. These effects have been investigated in the case of Roentgen rays in water and in wax (FRIEDRICH and GOLDHABER (5), QUIMBY and MC NATTIN (6), and for γ-rays by BRUZAU (7) and REES and CLARKE (8)). Although the mechanics of the Compton effect in simple scattering is well explained by the theory of KLEIN and NISHINA (9) no one has succeeded in developing a quantitative theory of multiple scattering in an extended medium. The Compton scattering involves the ejection of an electron from the scattering atom, and also the emission of the softened scattered quantum, both of which have characteristic ionising effects: it is at present impossible to form an estimate on theoretical grounds as to how far these processes will modify the distribution of ionisation in the scattering medium. The theory does show, however, that the older measurements of scatter with Roentgen rays can give little information as to the results to be expected with γ-rays. Superposed upon the scattering phenomena is the effect of differential absorption of the components of the primary radiation by the medium. The cumulative effect of these unknown factors gives rise to serious doubts as to the reliability of results obtained when computation of Radium dosage in a scattering medium is made on the basis of the inverse square law and the simple absorption law only. Direct experimental measurement of the distribution of intensity is essential to decide what errors, if any, the simplifying assumptions introduce into the theoretical formulae: this information is desirable, both when the scattering material is large in bulk, and also when it is of bulk comparable with the mass of tissue radiated during clinical application of Radium.

The most extensive series of measurements which have been made to date were published in 1929 by BRUZAU (7) who used a large water phantom (60 $\times$ 60 $\times$ 60 cm) and a rather large (14 mm $\times$ 17 mm) ionisation chamber with thin aluminium walls. BRUZAU found that between 6 cms and 15 cms from the source, the ionisation observed in his chamber was sensibly the same whether measurements were made in air or in water: that is, the loss of intensity by absorption was almost exactly compensated by the gain due to scatter. If heavy metals were used in place of aluminium as the chamber wall, the same result was not found: but such materials are less suitable than aluminium for measurements which are intended to have clinical application.

Measurements in the immediate neighbourhood of the source are difficult because very small ionisation chambers must be used in order to avoid errors due to the high value of the space-gradient of intensity.

Results published recently by GOLDHABER and GRIFFITH (10) and by BENNER (unpublished) (11) show that, between 3 mm and 15 mm, the Sievert formula gives correct relative values for intensity distribution: there may be some uncertainty as to the absolute value of the intensity. These measurements give experimental proof that secondary radiation from the needle surface is unimportant at distances greater than 3 mm, in water.

The experiments described below were undertaken to test BRUZAU's conclusion over a larger range of distances and to investigate how far they are affected by the size of the phantom employed. A source of 51.59 mg Radium in the form of sulphate was used as source, in a cylindrical capsule with a hemispherical end, 0.625 cm long and 0.540 cm in diameter. The screenage was 0.035 cm gold plus 0.030 cm platinum. The measuring

Fig. 1.

instruments were spherical condenser chambers of construction shown in Fig. 1, which is full size, (SIEVERT (13) Fig. 17 a and b, Fig. 14 b). Chambers (1—1) (1—2) and (3- -1) were of electron metal containing approximately 92.9 % Mg, 3.4 % Al, 3.3 % Zn, 0.2 % Cu, and a trace of lead. Chamber 1 B was of brass, of the same dimensions as (1—1). These were enclosed in thin rubber sheaths containing also a small tube of solid calcium chloride during irradiation in the phantom and when so protected could be immersed in water for several hours without loss of insulation. The technique of using these chambers has been fully described by SIEVERT (12, 13). Two phantoms were employed. The smaller one was made of celluloid and measured 31 cm × 19 cm × 19 cm depth. The radium source was placed in the central plane of the phantom, 3 cms from the end. The larger phantom was made of thin sheet iron measuring 60 cm × 60 cm × 60 cm, and the radium was placed in it 16 cm from the nearest side. There was no measurable secondary radiation from the walls of either phantom.

Results of a typical series of observations are shown in Fig. 2, where the distance in centimeters between the centres of radium capsule and condenser chamber is plotted as abscissa and the reciprocal of the square root of the observed ionisation current as ordinate. An inverse square relation between ionisation and distance would therefore give a straight

line on the diagram. The graph shows that this relation does in fact exist for the measurements in water at distances less than 12 cms in the large phantom, and less than 8 cms in the small one: within these distances, the measured intensity is in close agreement with the intensity calculated from the simple inverse square law, without allowance for absorption in

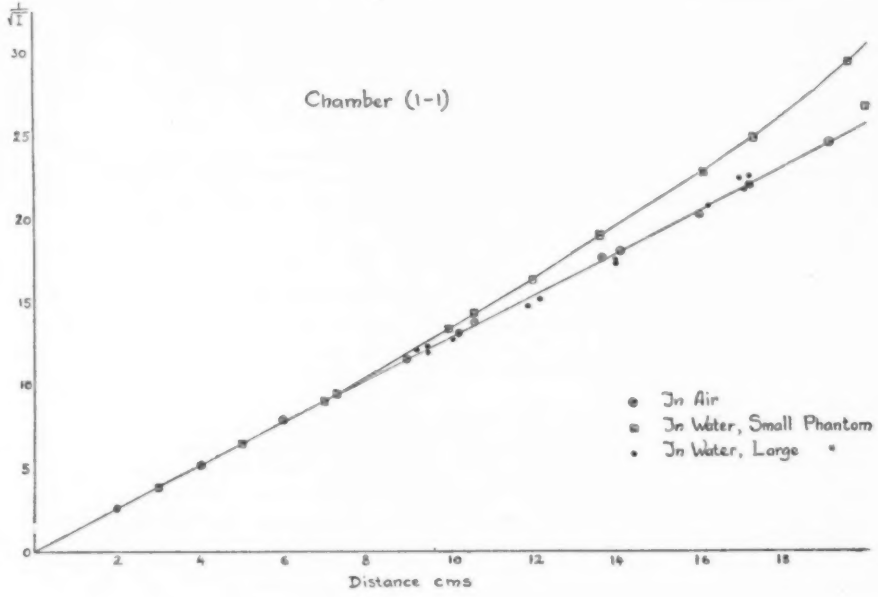

Fig. 2.

the water. This relation is well shown in Fig. 3, where the intensity measured at various distances in water is plotted as a percentage of that found at the same distance when the water is replaced by air. Since the quality of the radiation is different at different distances because of selective weakening of the softer components by absorption in the water on the one hand, and admixture of scattered radiation on the other, it is to be expected that the results obtained in such an investigation may depend on the type of chamber used to measure the ionisation. Fig. 3 shows to what extent this occurs with a variety of measuring chambers. The curves for the electron metal chambers agree in showing that divergence from the inverse square relation occurs in the large phantom at distances greater than about 12 cms and in the small phantom for distances greater than about 8 cms: in the small phantom the divergence increases rapidly with

distance. The curves for brass chambers lie higher than those for electron metal chambers, through differences in the wall effects.

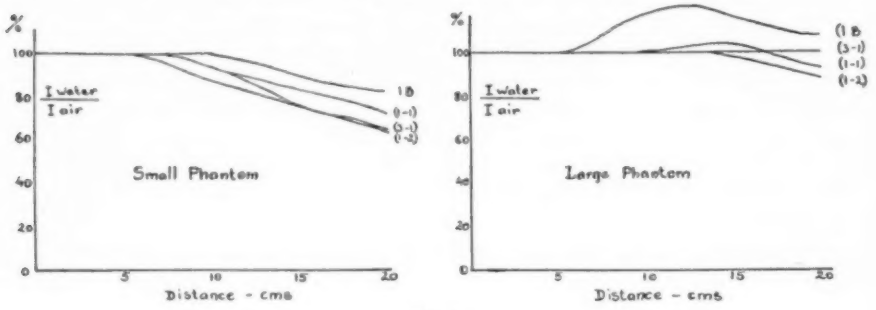

Fig. 3.

Taking these measurements into consideration with the previous work referred to above, it seems that in a mass of scattering material of the bulk usually met with in clinical practice, accurate calculation of dosage may be made at distances from 0.3 cm to about 8 cm by the Sievert formulae. In such calculations it may be assumed that absorption in the tissues is compensated by scatter.

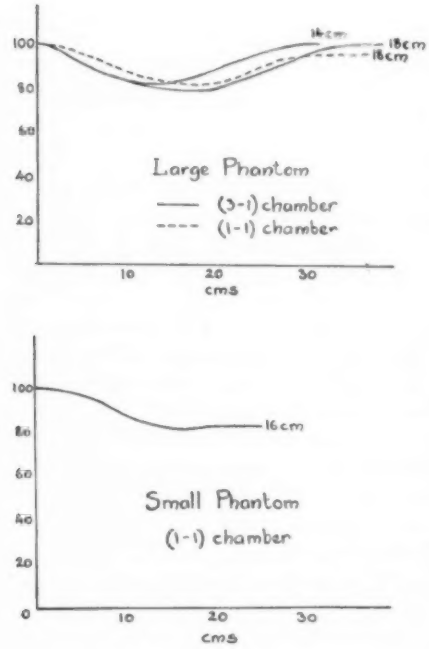

Fig. 4.

A further series of measurements was made in which the distance between the radium source and chamber was kept constant, while moving both by stages up to, and eventually into, the water of the phantom. In Fig. 4, the observed ionisation is plotted against the distance from the chamber to the wall of the phantom, the radium being on the left at the stated distance from the chamber as both move together towards the right. Using the large phantom, the curves show a decrease of ionisation followed by a rise when scatter increases as a

greater volume of water becomes strongly irradiated. They show a minimum when the radium is placed at the wall of the phantom. With the small phantom, the curves show the same initial fall, for which scatter is subsequently insufficient to compensate.

It is of interest to investigate these changes in more detail, and to study the case where the scattering medium contains considerable air spaces or regions of greater density.

SUMMARY

Measurements of the intensity of γ-rays in water phantoms of two different sizes are described, and the results are compared with computed intensities. Up to a certain distance (8 cm for the smaller phantom and 12 cm for the bigger one) the intensity measured in water was the same as that measured in air at the same distance. For greater distances the water measurements differed from those in air, and different values were found with the different types of chambers. The conditions are discussed under which calculation of dosage in radium therapy can be accurately made.

ZUSAMMENFASSUNG

Messungen der Intensität von γ-Strahlen in Wasserphantomen von zwei verschiedenen Grössen werden beschrieben, und die Resultate werden mit den berechneten Intensitäten verglichen. Bis zu einer gewissen Entfernung (8 cm für das kleinere Phantom und 12 cm für das grössere) war die in Wasser gemessene Intensität gleich der in Luft bei derselben Entfernung gemessene. Bei grösseren Entfernungen waren die in Wasser und in Luft gemessenen Werte verschieden, und mit verschiedenen Kammertypen wurden verschiedene Resultate erhalten. Die Verhältnisse, unter denen die Dosierung in der Radiumtherapie genau berechnet werden kann, werden diskutiert.

RÉSUMÉ

On décrit des mesures de l'intensité des rayons γ en phantomes d'eau de deux différentes grandeurs. Jusqu'à une certaine distance (8 cm pour le petit phantome et 12 cm pour le grand) l'intensité mesurée dans l'eau et dans l'air à la même distance est la même. Pour les distances supérieures les résultats dans l'eau et dans l'air sont différentes, et les chambres des différents types donnent des différentes valeurs. On discute les conditions dans lesquelles on peut calculer avec exactitude le dosage en curiethérapie.

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FROM THE PHYSICAL LABORATORY OF THE RADIUMHEMMET, STOCKHOLM.
(CHIEF: R. M. SIEVERT)

IONISATION MEASUREMENTS OF THE ROENTGEN RAY OUTPUT FROM TUBES AT DIFFERENT VOLTAGES AND WITH DIFFERENT FOCAL DISTANCES[1]

by

Robert Thoræus

The absolute intensity of the roentgen rays emitted from the anode at different voltages across the tube has been investigated by different methods by CARTER, BOWERS, AURÉN, WHIDDINGTON, BEATTY, RUTHERFORD and BARNES and others. In general the results show that the intensity is on the whole proportional to the square of the voltage.

From the radiological point of view, however, it is mainly the intensity as measured outside the tube which is of interest, and, moreover, the ionometric intensity measured under the conditions settled in connexion with the definition of the international *r*-unit. Here it should be noticed that only a small fraction of the radiation is absorbed in the ionised air-volume and because of this the results obtained cannot be expected to agree with the above mentioned square law, which refers to the total absorption of the radiation.

In order to investigate how far the ionometric results deviate from the square law I have carried out, by means of our standard air-ionisation chamber,[2] the measurements recorded below.

The constant and continuous tube voltage was measured by our standard sphere-gap (sphere diameter = 153 mm) and in all the measurements the length of the ionised air-volume in the standard chamber was 35 cm. The intensity measurements were carried out for two different tubes, a Metwa Metalix and an A. E. G. T III. For the sake of comparison I have taken the results obtained by BERTHOLD for two other tubes[3].

[1] Submitted for publication Oct. 26th 1933.

[2] Cf. THORÆUS, Acta Radiol. Supplem. XV, 1932.

[3] BERTHOLD: Grundlagen der technischen Röntgendurchstrahlung, Berlin 1930.

The results are plotted in the diagram Fig. 1, where the curves refer to the different tubes characterised as follows:

I = Metwa Metalix (glass window)
II = A. E. G. T III (glass wall about 0.75 mm thick)
III = type unknown (»ordinary» tube-glass, 1 mm thick)
IV = » » (tube-glass containing molybdenum and barium, thickness 1.5 mm).

III and IV are the tubes used by BERTHOLD, and the dotted curve is calculated from the square law. The intensity values in Fig. 1 correspond, for all the tubes, to the unfiltered radiation, and for No. II the

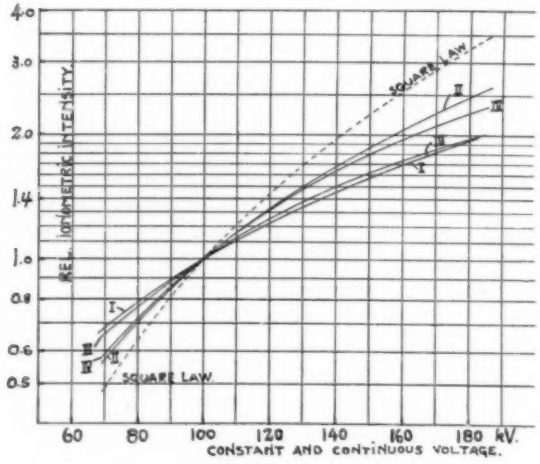


Fig. 1.

off-focus rays were excluded by using a lead diaphragm at a distance of about 5 cm from the glass wall of the tube. For each tube the intensity per 1 mA at 100 kV and at a focus distance of 1 metre is used as a unit value. The unit values found were as follows:

I = 2.3 *r*/min. II = 0.81 *r*/min.
III = 2.4 *r*/min. IV = 0.47 *r*/min.

For tube I, moreover, I have measured the intensity at different voltages for some filters generally employed. The results obtained are collected in the diagram Fig. 2.

A detailed study of the diagrams has yielded the following rather interesting result. Since for the square law curve the relative intensity

is expressed by the simple formula $i = \left(\frac{V}{100}\right)^2$ where V = the tube-voltage in kV, it was estimated, from the slope and general appearance of the curves, that they might be covered by formulae of the same type, and it seemed probable that the general formula $i = \left(\frac{V}{100}\right)^y$ would be suitable. On analysing the four curves in Fig. 1 I found in fact that by means of this formula the experimental results could be calculated with surprising accuracy. The values of y, found for the different curves, are as follows:

curve I . . . . . $y = 1.11$
II . . . . . $y = 1.53$
III . . . . . $y = 1.19$
IV . . . . . $y = 1.44$

In Table I are collected the experimental and calculated values for all the tubes. For tubes I and II the experimental and calculated values agree very well. The maximum difference is about 1 % and an average of about 0.5 % may be estimated. Regarding tubes III and IV, as measured by BERTHOLD, the agreement is also good. A maximum difference of about 3 % is found at 180 kV, while at other voltages a still better agreement is found. Considering that the accuracy in the determination of the ionometric intensity in r per min, is about 1 %, it may be said that the above formula reproduces the experimental values with sufficient accuracy.

Table I

Tube voltage V in kV	Tube I		Tube II		Tube III		Tube IV	
	exper. value	$\left(\frac{V}{100}\right)^{1.11}$	exper. value	$\left(\frac{V}{100}\right)^{1.53}$	exper. value	$\left(\frac{V}{100}\right)^{1.19}$	exper. value	$\left(\frac{V}{100}\right)^{1.44}$
70	0.68	0.673	0.57	0.577	0.66	0.652	0.59	0.597
90	0.89	0.889	0.85	0.849	0.88	0.879	0.86	0.857
110	1.11	1.112	1.16	1.149	1.13	1.120	1.16	1.148
130	1.34	1.338	1.49	1.494	1.38	1.367	1.47	1.459
150	1.57	1.568	1.86	1.861	1.62	1.621	1.79	1.794
165	1.75	1.743	2.15	2.153	1.78	1.816	2.02	2.057
180	1.94	1.920	2.48	2.464	1.95	2.012	2.27	2.331

The above interesting result encouraged me to analyse in a similar way the curves in Fig. 2. I found that these curves also can be covered by the same formula using an appropriate value of y for each filter. The experimental and calculated values are collected in Table II where it will be seen that an average accuracy of about 1.5 % is obtained.

Table II

Tube voltage V in kV	Unfiltered		1 Al		2 Al		4 Al		0.5 Cu + 1 Al		Tin-filter	
	exper. value	$\left(\frac{V}{100}\right)^{1.11}$	exper. value	$\left(\frac{V}{100}\right)^{1.59}$	exper. value	$\left(\frac{V}{100}\right)^{1.83}$	exper. value	$\left(\frac{V}{100}\right)^{2.19}$	exper. value	$\left(\frac{V}{100}\right)^{3.29}$	exper. value	$\left(\frac{V}{100}\right)^{4.76}$
70 . .	0.68	0.673	0.59	0.566	0.51	0.518	—	—	—	—	—	—
90 . .	0.89	0.889	0.85	0.845	0.82	0.821	0.77	0.791	—	—	—	—
110 . .	1.11	1.112	1.15	1.164	1.18	1.191	1.23	1.233	1.39	1.368	1.61	1.574
130 . .	1.34	1.338	1.50	1.517	1.60	1.616	1.77	1.775	2.42	2.371	3.51	3.491
150 . .	1.57	1.568	1.91	1.907	2.10	2.101	2.43	2.432	3.80	3.802	6.82	6.902
165 . .	1.75	1.743	2.22	2.218	2.50	2.518	3.00	2.998	5.18	5.20	10.80	10.80
180 . .	1.94	1.920	2.57	2.547	2.97	2.930	3.64	3.622	6.85	6.921	16.4	16.37

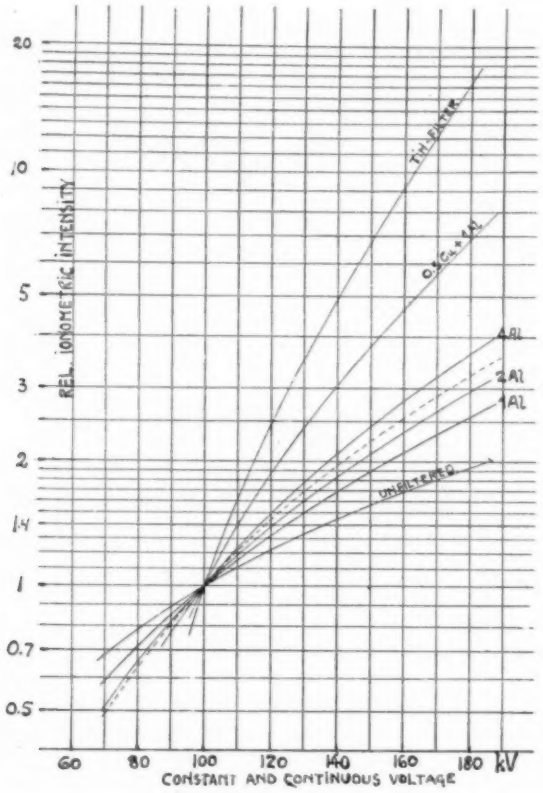


Fig. 2.

In a previous paper,[1] where the efficiency and equivalence of different filters were analysed and discussed, I introduced a specially defined λ_{max}, that is the maximum wave-length contained in the beam. As λ_{max} directly refers to the absorption properties of the filter material it is solely determined by the filter in question. When determining the λ_{max} value corresponding to a given filter the equivalent thickness of the glass wall or window of the tube should be added. For tube I the Al-equivalent of the glass window is about 0.2 mm. Thus we get:

for 1.2 Al	$\lambda_{max} = 1.15$ ÅU and	$y = 1.59$
2.2 Al	$= 0.95$	$= 1.83$
4.2 Al	$= 0.76$	$= 2.19$
0.5 Cu + 1 Al	$= 0.46$	$= 3.29$
Tin-filter	$= 0.29$	$= 4.76$

In the logarithmic diagram Fig. 3 the corresponding values of λ_{max} and y are plotted. It is seen that all the points lie on a straight line. From

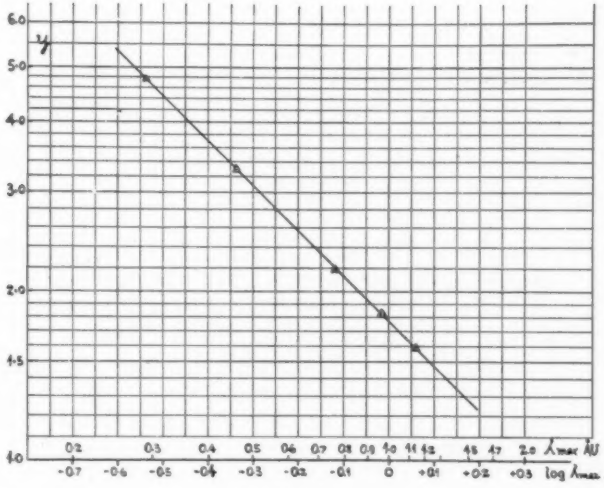


Fig. 3.

this diagram the values of y corresponding to other filters can be obtained.

In the above mentioned discussion of the equivalence of different filters it was pointed out that the conditions for a qualitative equivalence were: 1) the same λ_{max} and 2) the same relative spectral transparency.

[1] THORÆUS, loc. cit.

In consequence of this and of the results given above, qualitatively equivalent filters should be expected to have the same value of the exponent y. In order to test this I have measured the intensity at different voltages for a filter of 17 Al which is qualitatively equivalent to 0.5 Cu + 1 Al. The values so obtained are collected in Table III together with those for 0.5 Cu + 1 Al, taken from Table II. As may be seen the values are identical within an average accuracy of about 1.5 % which strongly supports the conclusions arrived at.

Table III

Tube voltage V in kV	0.5 Cu + 1 Al exper. value	$\left(\frac{V}{100}\right)^{3.29}$	17 Al exper. value
100	1.00	1.00	1.00
110	1.40	1.368	1.44
130	2.42	2.371	2.38
150	3.80	3.802	3.75
165	5.18	5.20	5.12
180	6.85	6.921	6.80

The surprisingly good agreement found between the experimental results and the calculated values seems to suggest that, within the voltage range used in roentgen therapy, the formula $i = \left(\frac{V}{100}\right)^y$ is probably of general validity regarding the relative ionometric intensity as a function of the tube voltage. A definite answer, however, can only be obtained by further systematic measurements for different tubes — as carried out for tube I — which I hope to be able to do later on.

In a recent paper[1] KAYE and BINKS published some measurements of the intensity at different focus distances. They find that the inverse square law does not hold exactly and that the deviation from this law depends upon both the filtration and the focus distance. The deviations seem to be more pronounced with the shorter focus distances.

A few months ago I made, for another purpose, some measurements of the intensity at different focus distances (30—70 cm) as generally used in roentgen therapy. Since my results differ from those of KAYE and BINKS they will be briefly recorded below.

The intensity Ip from a Metwa Metalix tube with maximum aperture and excited by constant and continuous voltage, was measured by means of a spherical graphite chamber with an outside diameter

[1] The Brit. Journ. of Radiol. Sept. 1933.

of 16 mm arranged at the centre of the beam. A previous calibration of this chamber against our standard air-ionisation chamber showed a close parallelism for all the radiation qualities used. The focus distance F was measured to the centre of the chamber.

The values of Ip for $F = 50$ cm are referred to as unit values, and the results obtained are collected in table IV.

Table IV

Filter and voltage	$F = 30$ cm rel. intens. Ip	$F = 40$ cm rel. intens. Ip	$F = 50$ cm rel. intens. Ip	$F = 70$ cm rel. intens. Ip
1 Al, 100 kV	2.79	1.56	1.00	0.501
2 Al, 120 kV	2.89	1.55	1.00	0.505
4 Al, 145 kV	2.84	1.57	1.00	0.507
0.25 Cu + 1 Al, 165 kV	2.80	1.55	1.00	0.508
0.5 Cu + 1 Al, 165 kV	2.77	1.56	1.00	0.517
1.0 Cu + 1 Al, 165 kV	—	1.56	1.00	0.518
Tin-filter*), 165 kV	2.80	1.53	1.00	0.516

*) Qualitatively equivalent to 2.1 Cu + 1 Al as given by the author in Acta Radiol. Supplementum XV.

It is seen from the table that the deviations are very small, and, within the limits of experimental error, the values experimentally obtained can be considered to be identical. When calculating the average we get 2.81 for $F = 30$ cm, 1.55 for $F = 40$ cm, and 0.511 for $F = 70$ cm. From the inverse square law we get 2.77, 1.56 and 0.510 respectively. As may be seen a very good agreement is found between the values experimentally obtained and those calculated from the inverse square law, for all the filters used, and at these relatively small focus distances.

Note added to the proof. In a recent paper by L. TAYLOR (The Amer. Journ. of Roentgenology, Sept. 1933, p. 368), I have found some measurements of the ionometric intensity at voltages between 90 and 150 kV from a constant-potential machine. The measurements refer to »a single type of thin-walled cerium glass coolidge tube», a distance of 50 cm between the center of the focal spot and the center of the chamber, a beam diameter of 5.5 cm as determined by a diaphragm 15 cm before the chamber, and a filter of 0.56 Cu + 1 Al. The intensity was measured by means of a calibrated thimble ionisation chamber.

When analysing the intensity values experimentally obtained by TAYLOR, I found that his values also are covered by the formula $i = \left(\frac{V}{100}\right)^y$, where the appropriate y-value was found to be 3.28. The above mentioned filter corresponds to a λ_{max} of 0.45, and for this value the diagram in figure 3 gives an y-value of 3.37. With respect to the difficulties of getting correct intensity values from TAYLOR's diagram the agreement between the y-values may be considered to be very good, which further supports my conclusions.

SUMMARY

1) The author submits measurements of the ionometric intensity at different voltages within the range generally used for roentgen therapy (70—180 kV).

2) An analysis of the experimental results shows that the curves obtained for different tubes and different filters can be reproduced by the formula $i = \left(\frac{V}{100}\right)^y$ where i = the relative ionometric intensity and V = the constant and continuous voltage in kilovolts. The exponent y is found to be closely connected with the filter. A separate test shows that qualitatively equivalent filters, as might be expected, have identically the same value of y.

3) As a contribution to the question as to whether the ionometric intensity is proportional to the inverse square of the focus distance the author submits some measurements within 30—70 cm for seven different radiation qualities.

Within the measured range the results have verified such a proportionality.

ZUSAMMENFASSUNG

1) Verf. gibt Messungen der ionometrischen Intensität bei verschiedenen Spannungen, die gewöhnlich für Röntgentherapie verwendet werden (70—180 kV).

2) Eine Analyse der Versuchsresultate zeigt, dass die für verschiedene Röhren und verschiedene Filter erhaltenen Kurven durch die Formel $i = \left(\frac{V}{100}\right)^y$ wiedergegeben werden können; dabei ist i = der relativen ionometrischen Intensität und V = die konstante und kontinuierliche Spannung in Kilovolt. Der Exponent y steht, wie sich ergab, in engem Zusammenhang mit dem Filter. Eine besondere Untersuchung zeigte, dass qualitativ äquivalente Filter, wie zu erwarten war, einen identischen Wert von y haben.

3) Als Beitrag zur Frage, ob die ionometrische Intensität sich umgekehrt proportional zum Quadrat der Fokusdistanz verhält, gibt Verf. einige Messungen innerhalb 30—70 cm für sieben verschiedene Strahlenqualitäten.

Innerhalb des untersuchten Gebietes haben die Resultate eine solche Proportionalität bestätigt.

RÉSUMÉ

1) L'auteur communique des mesures de l'intensité ionométrique aux différents voltages généralement usités en roentgenthérapie (70—180 kV).

2) Une analyse des résultats expérimentaux montre que les courbes obtenues pour différentes ampoules et pour différents filtres peuvent être reproduites par la formule $i = \left(\frac{V}{100}\right)^y$, dans laquelle i = l'intensité ionométrique relative et V = le voltage constant et continu en kilovolts. L'exposant y s'est montré être en rapports étroits avec le filtre. Des expériences spéciales qui ont été faites, il résulte, ainsi qu'on pouvait s'y attendre, que des filtres qualitativement équivalents ont une valeur identiquement égale de y.

3) Comme contribution à la question de savoir si l'intensité ionométrique est inversement proportionnelle au carré de la distance focale, l'auteur communique une série de mesures faites entre 30 et 70 cm pour sept qualités différentes de radiation.

Dans la région examinée les résultats ont confirmé cette proportionnalité.

AUS DEM PHYSIKALISCHEN LABORATORIUM DES RADIUMHEMMET IN STOCKHOLM.
VORSTAND: R. M. SIEVERT

STRAHLUNGSMESSUNGEN AN MIT RADIOLOGISCHEN ARBEITEN BESCHÄFTIGTEM PERSONAL[1]

1. MESSUNGEN IM DIAGNOSTIKBETRIEB

von

Sven Benner

Das Interesse für Bestimmungen der Bestrahlung, der das Personal bei radiologischen Arbeiten ausgesetzt ist, datiert von der Zeit her, als man die grossen Gefahren eines unzureichenden Strahlenschutzes entdeckte. Eine grosse Zahl von Messungen sind auch ausgeführt worden, im allgemeinen nach der Ionisationsmethode. Hierbei ist man bislang genötigt gewesen, die Intensität an einer Anzahl von Punkten um den Röntgenapparat herum, z. B. ein Durchleuchtungsstativ, zu messen, während die Röhre in Betrieb ist. Dann schätzt man die Zeit, während welcher der am Apparat Arbeitende die einzelnen Körperteile an den verschiedenen Punkten aussetzt, wobei besonders diejenigen Punkte, an denen eine grosse Strahlungsintensität gemessen worden ist, von Interesse sind. Man kann dann die Dosis, die die betreffende Person an den verschiedenen Körperteilen während eines Tages erhält, berechnen. Die Schätzung der genannten Zeit ist aber nur mit sehr geringer Genauigkeit möglich, insbesondere, wenn die tägliche Arbeit einigermassen ungestört und ohne Unterbrechungen durch immer wiederkehrende Aufzeichnungen vor sich gehen soll. Nun wünscht man aber diejenige Dosis zu finden, die im Mittel während eines Tages bei gewöhnlicher Arbeitsweise empfangen wird, denn die Dosis, die an einzelnen Tagen unter vom Gewöhnlichen abweichenden Arbeitsverhältnissen empfangen wird, hat einen sehr geringen Einfluss auf die Gesamtbestrahlung während des Arbeitsjahres.

Eine Methode, die Bestrahlung der einzelnen Körperteile direkt zu messen, ohne die gewöhnliche Arbeit zu stören, hat man in der photographischen Methode. Wegen der grossen Abhängigkeit von der Wellenlänge und verschiedenen Nebenumständen ist es aber bei dieser Methode

[1] Bei der Redaktion am 9. X. 1933 eingegangen.

Tabelle 1. In der Röntgendiagnostik an

Krankenhaus	a						b			c					
Person	1 (Arzt)			2 (Arzt)			3 (Arzt)			4 (Arzt)			5 (Schwester)		
Anzahl Tage	2	1	2	2	2	2	2	1	1	1	1	2	2	1	1
Gesamte Durchleuchtungszeit (Minuten pro Tag)	10	90	45	68	45	60	34	84	?	80	93	68	107	102	97
Gesamte Exponierungszeit (Sekunden pro Tag)	?	?	?	?	?	?	?	20	12	47	24	22	26	106	20
Untersuchte Punkte: Rechte Hand: ulnare Seite des Endphalanges des Zeigefingers	0.01	0	0	0.015	0	0.02	0.04	0.09	0.01	0.08	0	0.005	0.02	0.035	0.01
Linke Hand, der gleiche Punkt	0.015	0.01	0	0.11	0.005	0.01	0.04	0.06	0.01	0.005	0.01	0	0 01	0.03	0.08
Nasenwurzel	0.35	0.015	0	0.01	0	0.01	0.04	0.025	0	0	0.01	0.05	0	0.01	0
Proc. spinos. vom vert. promin.	0	0	0	?	0	0.01	0	0	(0)	0	0	0.005	0.005	0	0
Innenseite des rechten Ellenbogens	0.23	0	0	0	0	0.01	0	0	0	0.01	0.025	0.065	0.025	0	0
Innenseite des linken Ellenbogens	0	0.005	0.005	0.005	0	0.01	0.005	0	0 01	(0.005)	0.06	0	0.01	0.02	0
Rechte Brustwarze	0.01	0.08	0	0.005	0	0	0.01	0	0.005	0	0	0.01	0.005	0	0
Linke Brustwarze	0.03	0.065	0	0	0	0	0.06	0.01	0	0.015	0	0	0	0	0
Rechte Leiste	0	0	0	0	0	0.02	0	0.02	0	0.01	0	0.02	0.005	0	0
Linke Leiste	0.02	0	0.005	0.01	0	0.01	0.01	0	0	0.01	0	0.02	0	0	0
Rechter Spann	0.04	0	0	0	0	?	0.04	0	(0)	0.04	0.01	0.005	0	0.01	0.01
Linker Spann	0	0	0	0	0	0.005	0	0	0	0.03	0.03	0.02	0	0.025	0.01
Schutzhandschuh	ja	ja	ja	ja	ja	ja	nein	nein	nein	ja	ja	ja	—	—	—
Schutzschürze	nein	nein	nein	nein	nein	nein	nein	nein	nein	nein	nein	nein	—	—	—
Schutzkanzel	ja	ja	ja	ja	ja	ja	ja	ja	ja	ja	ja	ja	—	—	—

Bemerkungen zu der Tabelle. *Krankenhaus a:* 1 Vierventilmaschine von Järnh (Skandia) von umgebaut. 1 Trochoskop aus Holz, wenigstens 10 Jahre alt. *Krankenhaus b:* 1 Siemensmaschine mit 1 Trochoskop, beide aus Stahl, von Schönander von 1928—1929. *Krankenhaus c:* 1 Siemens Polyphos Forssellstativ, letzteres von Schönander. Gesamte Ausrüstung im Jahre 1929 installiert. *Krankenhaus* von 1912. 2 Forssellstative aus Holz von 1918, später umgebaut. Für gewöhnliche Aufnahmen von Schönander, 1 älterer Schädeltisch, 2 alte Holztrochoskope nach Forssell. *Krankenhaus e:* Siemens Siemens 3-Phasenmaschine Gigantos von 1930. Forssellstativ und Universaltisch von Schönander. 1 Vierventilmaschine von Järnh von 1928. Stativ von Schönander von 1931, Universaltisch von Järnh

Personal gemessene Dosen in r pro Tag

d								e			f			g			
6 (Arzt)			7 (Arzt)		8 (Schwester)			9 (Arzt)			10 (Arzt)			11 (Arzt)			12 Schwester
1	2	1	2	3	3	2	1	2	2	2	1	2	2	1	1	1	1
27	26	20	28	10	16	22	37	53	118	45	150	95	135	180	120	120	?
29	14	20	21	7	74	147	197	23	30	7	13	13	14	15	12	13	?
0.12	0.065	0.065	0.05	0.05	0	0.01	0	(0.34)	0.325	(0.035)	0.11	0.09	0.20	0.195	0.14	0.185	0.02
0.01	0.025	0.065	0.11	0.05	0	0.01	0.04	0.02	0.01	(0)	0.11	0.09	0.165	0.56	0.175	0	0.035
0.005	0	0.035	0.06	0.02	0.01	0.005	0	0.01	0	(0)	0	0.01	0	—	0.01	0.01	0
0	0	0	(0.08)	0.01	0.01	0.01	0.01	0	(0)	(0)	0.005	0	0	—	0	0	0
0.01	0	0	0.03	0	0	0	0.01	0.04	(0)	(0)	0.01	0.005	0.01	0.01	0.01	0.005	0.01
0.01	0	0	0.02	0.05	0.01	0.01	0.03	0	0.01	(0)	0.005	0.01	0	0.015	0	0.005	0
0	0	0	(0.11)	0	0	0	0.02	(0)	(0)	(0)	0	0.005	0	0.01	0	0	0
0	0.03	0	(0.005)	0.01	0	0.015	0.01	(0)	(0)	(0)	0.005	0.005	0	0.01	0.005	0.005	0
0	0	0	0.015	0.01	0.005	0	0.02	(0)	0.005	(0)	0.01	0	0	0	0	0	0
0	0	0.035	0.025	0.01	0	0.005	0.005	(0)	0	(0)	0.025	0.03	0.03	0.005	0	0.01	0.005
?	0	0.02	0.035	0	0	0	0.02	(0)	0.03	(0)	0.025	0.05	0	0.01	0	0.005	0
0	0	0	0	0.01	0	0	0.015	0.005	0.01	(0)	0.005	0.025	0.005	0.01	0.025	0.015	0.01
ja	ja	ja	ja	ja	—	—	—	nein	teil-weise	nein	teil-weise	nein	nein	teil-weise	nein	teil-weise	—
ja	ja	ja	ja	ja	—	—	—	nein	nein	nein	nein	nein	nein	nein	nein	nein	—
teil-weise	teil-weise	teil-weise	ja	teil-weise	—	—	—	ja	ja	ja	ja	ja	ja	ja	ja	ja	—

etwa 1928. 1 Durchleuchtungsstativ von Schönander von 1931, 1 altes Forssellstativ von Järnh, später rotierendem Gleichrichter, etwa von 1924. 1 Vierventilmaschine von Järnh von 1929. 1 Forssellstativ, mit Teleortoskop und Trochoskop, letzteres von Järnh. 1 Järnh Skandia Intensiv mit Trochoskop und *d:* 2 Järnhmaschinen mit rotierendem Gleichrichter von 1919 bzw. 1925, 1 ähnliche Seifertmaschine 2 Holztische Albers-Schönberg, 1 amerikanischer Bucky-Tisch aus Stahl, 1 Urologietisch nach Lysholm Polyphos von 1928. Siemens Ortoteleskop. Holztrochoskop mit Sekundärstrahlenschutz. *Krankenhaus f: Krankenhaus g:* 1 Siemens Dreiphasenmaschine von 1930—1931, 1 ähnliche Maschine von Järnh, von 1931.

nur mit sehr geringer Genauigkeit möglich, quantitativ zuverlässige Werte zu berechnen. Dagegen scheint die Kondensatorkammermethode von SIEVERT[1,2] sehr geeignet zu sein, da sie die Genauigkeit der Ionisationsmethode mit der Bequemlichkeit der photographischen Methode vereinigt. SIEVERT[3] hat auch diese Frage berührt und die Resultate einiger Messungen mitgeteilt. Ich habe nachher eine mehr systematische Messreihe ausgeführt; die Messungen auf dem Gebiet der Röntgendiagnostik sind nunmehr abgeschlossen und sollen hier mitgeteilt werden. Die Resultate der Messungen bei Röntgen- und Radiumtherapie sollen später folgen.

Bei den Versuchen wurden sphärische Kondensatorkammern vom Typus (1—1) 10 und (1—2) 10, beide mit einem äusseren Durchmesser von 10 mm, benutzt. Der innere Durchmesser der äusseren Kugel war bei beiden Typen 8 mm (Wandstärke also 1 mm). Als Material wurde Elektronmetall (Zusammensetzung nach SIEVERT 92.9 % Mg, 3.4 % Al, 3.3 % Zn, 0.2 % Cu, Spuren von Pb) benutzt. Der Durchmesser der inneren Kugel war beim ersten Typus 6 und beim letzteren 4 mm. Die ersteren hatten also grössere Kapazität und geringeres Luftvolumen und waren deshalb weniger empfindlich als die letzteren.

Bevor eine Messreihe angefangen wurde, wurden 15 Kammern, deren Isolation durch Ablesen des Ladungsverlustes während einiger Tage Aufbewahrung im Laboratorium geprüft worden war, wieder geladen, in kleine Stücke impregnierte Leinewand eingewickelt, nummeriert und in einem Etui an die Versuchsperson gesandt. Diese hatte dann 12 der Kammern laut einem mitfolgenden Schema (vgl. Tabelle 1) an verschiedenen Körperteilen zu befestigen, während 3 als Kontrolle unbestrahlt aufbewahrt wurden. Die 12 ersten Kammern wurden während der täglichen Arbeit 1—3 Tage, je nach Empfindlichkeit der Kammern und je nach Arbeitsmenge, getragen. Nach dem Versuch wurden die Kammern nebst Angaben über Arbeitsmenge, Schutzanordnungen u. s. w. an Radiumhemmets Fysiska Laboratorium zurückgesandt, wo die nach der Bestrahlung verbliebene Ladung an einem Elektrometer abgelesen wurde. Da die beiden Kammertypen mit Hilfe einer Standardkammer für verschiedene Qualitäten in r-Einheiten geeicht worden waren, konnten, nach Korrektion für Isolationsfehler, die erhaltenen Dosen berechnet werden.

In der Regel wurden drei Versuche pro Person ausgeführt, um Zufälligkeiten zu eliminieren. Soweit möglich, wurden die empfindlicheren (1—2) 10-Kammern benutzt, aber da die Anzahl der Kammern, die den strengen Forderungen an die Isolation entsprachen, begrenzt war, und die Kammern dann und wann für einige Tage im Laboratorium zurück-

[1] R. SIEVERT, Acta Radiol. *12*, S. 190, 1931.
[2] R. SIEVERT, Acta Radiol. Suppl. *14*, 1932.
[3] R. SIEVERT, Acta Radiol. Suppl. *14*, S. 144, 1932.

behalten werden mussten, um die Isolation zu überprüfen, wurden bisweilen auch die (1—1) 10-Kammern herangezogen, um die langwierigen Versuche etwas zu beschleunigen.

Diagnostikmessungen wurden bis zu einer Anzahl von 33, an 7 verschiedenen Krankenhäusern an 12 Versuchspersonen (9 Ärzte und 3 Schwestern) ausgeführt. Die erhaltenen Resultate und die Verteilung der Kammern gehen aus der Tabelle hervor. Die Verteilung auf die verschiedenen Körperteile wurde nach Beratung mit Ärzten bestimmt. Die Kammern an den Zeigefingern waren vielleicht den Versuchspersonen etwas lästig, besonders wenn sie Schutzhandschuhe trugen, aber ich fand es wertvoll, Messungen an diesen der Strahlung besonders ausgesetzten Punkten auszuführen.

Die Tabellen zeigen ferner die Versuchsdauer, die gesamte Durchleuchtungszeit in Minuten pro Tag und die gesamte Exponierungszeit in Sekunden pro Tag, ferner ob Schutzhandschuhe (bei Palpierungen), Schutzschürze und Schutzkanzel verwendet wurden oder nicht. Aus den Originalprotokollen und aus Briefen von den Versuchspersonen habe ich weitere ähnliche Angaben entnommen; diese wollte ich aber nicht in die Tabellen aufnehmen, um letztere nicht zu umfangsreich zu gestalten. Fragezeichen in einem Feld bedeutet, dass gewisse Angaben mir nicht zugekommen sind, oder dass eine Messung aus irgend einem Grunde misslang. Die Klammer um einige Werte bedeutet, dass sie relativ unsicher sind, im allgemeinen wegen verschlechterter Isolation der Kammern. Sonst ist die Unsicherheit meist gering, im allgemeinen einige Tausendstel r pro Tag. Fehler bei Bestimmung der Empfindlichkeit der Kammern geben immer denselben *relativen* Fehler in den gemessenen Dosen; da diese meist klein waren, spielen diese Fehler gegenüber direkten Ablesungsfehlern und Isolationsfehlern im allgemeinen keine Rolle. Der Umstand, dass die Kammern nicht ganz wellenlängenunabhängig sind, hat deshalb auch nur kleine Fehler im Gefolge.

Beim Betrachten der Tabellen findet man einige Züge, die vielleicht recht selbstverständlich erscheinen, was aber nicht hindert, dass es von Wert ist, sie durch direkte Messungen zu kontrollieren. So sind die beobachteten Dosen meist klein und meist geringer, als die allgemein angenommene Toleranzdosis von 0.2 r/Tag. Bei den Schwestern wurde bei weitem nicht dieser Toleranzwert erreicht, auch nicht, wenn sie an einer grossen Zahl von gewöhnlichen Aufnahmen ausser der Durchleuchtungsarbeit teilnahmen (vgl. z. B. Versuchspersonen 5 und 8). Wenn die Ärzte sich der genannten Toleranzgrenze nähern oder sie überschreiten, findet man im allgemeinen die grössten Dosen an den Händen. Eine eigentümliche Ausnahme bildet die erste Messung an Person 1.

Der zu erwartende Zusammenhang zwischen Arbeitsmenge und gemessener Dosis wird von der Tabelle merkwürdigerweise nicht bestätigt.

Person 1 hatte z. B. bei der ersten Messung wenig Arbeit und doch in zwei Punkten hohe Dosen, bei der zweiten Messung viel mehr Arbeit und doch in den meisten Punkten kleinere Dosen. Ähnliches gilt für die beiden ersten Messungen mit Person 3. Person 7 hat trotz wenig Arbeit relativ hohe Dosen. Offenbar spielen hier so viele andere Umstände mit, dass die erwartete Abhängigkeit verdeckt wird.

Die an den Händen gemessenen Dosen werden bei Verwendung von Schutzhandschuhen bedeutend kleiner. Person 6 hat jedoch trotz Schutzhandschuhe und relativ wenig Arbeit recht hohe Dosen an der rechten Hand.

Individuelle Verschiedenheiten machen sich bemerkbar. Personen 1, 2 und 4 bekamen z. B. viel geringere Dosen als Personen 3, 6, 10 und 11; bei den beiden letzteren kann dies jedoch durch die grosse Arbeitsmenge bedingt sein.[1] Ob der Unterschied zwischen den Personen auf verschieden vorsichtiger Arbeitsweise oder auf Verschiedenheit der Apparate u. s. w. beruht, kann nicht entschieden werden.

Ob der Schutz an den verschiedenen Krankenhäusern verschieden gut ist, lässt sich schwer beurteilen. Um individuelle Unterschiede zwischen den Ärzten auszuscheiden, können wir nur solche Krankenhäuser vergleichen, in denen Messungen an mehreren Ärzten ausgeführt worden sind, in diesem Fall also die Krankenhäuser a und d. Beim ersteren Krankenhaus finden wir im allgemeinen geringere Dosen als beim letzteren, ein paar wahrscheinlich zufälligerweise entstandene hohe Werte beim ersten Versuch mit Person 1 ausgenommen.

Eine schwer zu erfassende Fehlerquelle bei diesen Versuchen ist die psychologische. Schon das Bewusstsein, Kammern bei sich zu tragen, die jede durch Fahrlässigkeit verursachte Bestrahlung registriert, wird einige Personen an den Versuchstagen vielleicht zu besonders grosser Vorsicht veranlassen. Dagegen hat mir Person 11 mitgeteilt, dass sie sich besonders beim ersten Versuch der Strahlung ausnehmend viel ausgesetzt habe, um zu erfahren, ob dann hohe Dosen gemessen werden würden. Diese Messungen sind also nicht zuverlässig.

ZUSAMMENFASSUNG

Mit Hilfe der Kondensatorkammermethode SIEVERTS sind die Strahlungsdosen, die Ärzte und Schwestern in röntgendiagnostischer Tätigkeit an einzelnen Körperteilen erhalten, bestimmt worden. Diese Dosen waren meist recht klein und weit unterhalb der allgemein angenommenen Toleranzgrenze von 0.2 r/Tag. Der Einfluss verschiedener Faktoren auf das Resultat wird diskutiert.

[1] Vgl. auch die Bemerkung im Schlusswort.

SUMMARY

The irradiation doses which doctors and nurses receive in different parts of their body during roentgen diagnostic work have been measured by aid of SIEVERT's condenser chamber method. The doses were generally rather small and far below the usually accepted tolerance limit of 0.2 r/day. The influence of different factors on the result are discussed.

RÉSUMÉ

On a mesuré, à l'aide des chambres condensateurs de SIEVERT, les doses d'irradiation que les médecins et les infirmières reçoivent pendant leur travail rœntgendiagnostique. En général, ces doses étaient assez petites et au-dessous de la limite de tolérance généralement acceptée de 0.2 r/jour. On discute l'influence de différents facteurs sur le résultat.

PROCEEDINGS

OF THE

NORTHERN ASSOCIATION FOR MEDICAL RADIOLOGY

(— NORDISK FÖRENING FÖR MEDICINSK RADIOLOGI —)

AN ACCOUNT OF THE SEVENTH CONGRESS OF THE ASSOCIATION

HELD IN THE HIGH COMMERCIAL SCHOOL, STOCKHOLM

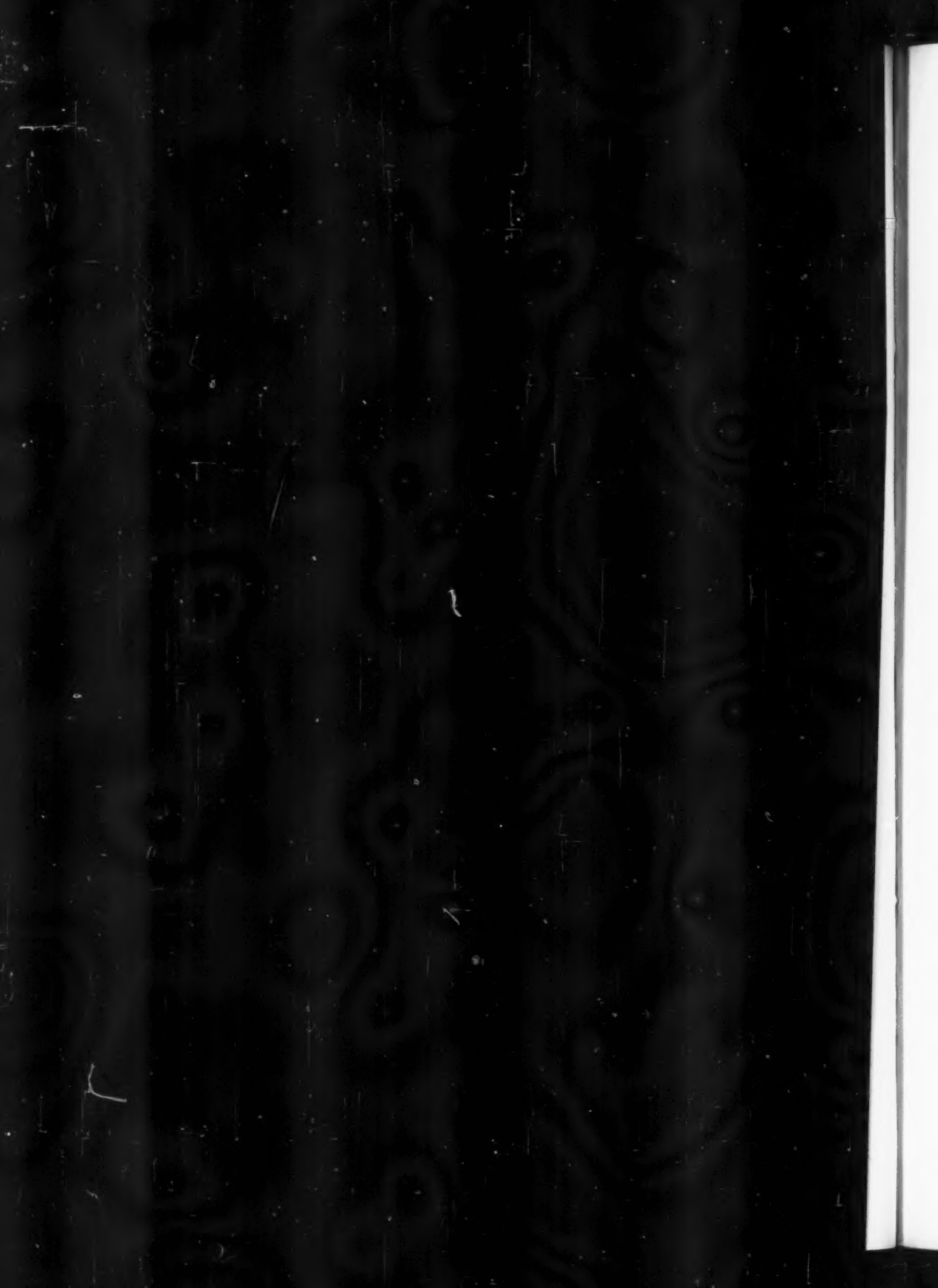
JUNE 29th to JULY 1st, 1933

Edited by

Nils Westermark, Secretary-General

LIST OF OFFICERS.

President: Prof. GÖSTA FORSSELL.
Honorary Presidents: Dr. S. A. HEYERDAHL, Dr. P. FLEMMING MØLLER and Dr. G. A. WETTERSTRAND.
Secretary-General: Dr. NILS WESTERMARK.
Secretaries: Drs. R. BULL ENGELSTAD, POUL JACOBY, GÖSTA JANSSON and CARL SANDSTRÖM.



MINUTES OF THE SEVENTH ORDINARY MEETING OF THE NORTHERN ASSOCIATION FOR MEDICAL RADIOLOGY.

STOCKHOLM, SWEDEN

June 29, 1933.

1.

The President, Professor FORSSELL, opened the meeting and after welcoming those present spoke in memory of Prof. JOHN BERG, Prof. GUIDO HOLZKNECHT, and Prof. HERMANN RIEDER, honorary members as well as Dr HANS JESSEN PANNER, Dr LEIF ARNTZEN and Dr EINAR WINTHER, members of the association who had died since the last meeting.

2.

Since the Secretary-General, Dr CHRISTIAN BAASTRUP was prevented from being present on account of illness, Dr NILS WESTERMARK was elected as substitute.

3.

The report of the Secretary-General was read, approved and accepted with gratitude.

4.

The order of proceedings was fixed in accordance with the program arranged by the board whereby 45 minutes were to be allowed for speeches given on invitation, 20 minutes for other speeches, 10 minutes for a previously announced discussion and 5 minutes for any other discussion.

5.

Dr S. A. HEYERDAHL, Dr P. FLEMMING MØLLER and Dr G. A. WETTERSTRAND were elected as Honorary-Presidents of the Congress and Dr R. BULL ENGELSTAD, Dr POUL JACOBY, Dr GÖSTA JANSSON and Dr CARL SANDSTRÖM as Secretaries of the Congress.

6.

The proposal worked out by the board with regard to alteration of the statutes was presented.

7.

The proposal of the board for the election of Honorary Members was presented.

8.

Dr Å. ÅKERLUND was elected to sign the minutes in addition to the chairman.

9.

The meeting was declared closed.

Approved
GÖSTA FORSSELL. NILS WESTERMARK.
Secretary General

ÅKE ÅKERLUND.

July 1, 1933.

1.

The proposal of the board in regard to the alteration in the statutes was accepted with a few slight changes in paragraph 6 and clause 2 in the »Rules of Procedure» so that the statutes will have the wording found on page 668.

2.

It was resolved, on the invitation of Finland, that the next meeting should be held in Helsingfors, June 1936, and that the general order of proceedings should conform to that just adopted.

3.

There were elected as Finland's representatives on the board Dr GÖSTA JANSSON, Dr ILMARI SALLINEN and Dr S. MUSTAKALLIO, as Denmark's representatives Dr P. FLEMMING MØLLER and Dr JENS JUUL, as Norway's representatives Dr S. A. HEYERDAHL and Dr R. BULL ENGELSTAD and as Sweden's representatives Prof. GÖSTA FORSSELL, Dr LARS EDLING and Dr NILS WESTERMARK.

4.

Dr G. A. WETTERSTRAND was elected as President for the next period, Dr I. SALLINEN as Secretary-General and Dr NILS WESTERMARK as Treasurer.

5.

Dr CHRISTIAN BAASTRUP and Secretary CARL O. EDEMAR were elected as auditors for the next period and as their substitutes Dr V. FINSEN and Mr. C. B. SCHMIDT.

6.

The following were elected as Honorary Members:

Dr. A. E. BARCLAY, Cambridge,
Prof. HANS HEINRICH BERG, Dortmund,
Prof. NIELS BOHR, Copenhagen,
Prof. ARISTIDE BUSI, Rom,

Prof. J. van Ebbenhorst-Tengbergen, Amsterdam,
Dr. James Ewing, New York,
Prof. W. Friedrich, Berlin,
Prof. Hans Holfelder, Frankfurt a/Main,
Mr. C. Thurstan Holland, Liverpool,
Prof. Hermann Holthusen, Hamburg,
Dr. G. W. C. Kaye, London,
Dr. R. Ledoux-Lebard, Paris,
Dr. J. M. Woodburn Morison, London,
Prof. John Murdoch, Brussels,
Dr. Th. Nogier, Lyon,
Prof. Maria Ponzio, Turin,
Dr. Douglas Quick, New York,
Prof. Claude Regaud, Paris,
Prof. H. R. Schinz, Zürich,
Prof. Manne Siegbahn, Upsala,
Prof. Pasquale Tandoja, Naples,
Dr. Francis H. Williams, New York,
Prof. Francis Carter Wood, New York.

7.

Dr. Å. Åkerlund was elected to sign the minutes in addition to the Chairman.

8.

The meeting was declared closed.

Approved

Gösta Forssell. Nils Westermark.
Secretary General

Åke Åkerlund.

SCIENTIFIC TRANSACTIONS.

I. W. Magnusson, Stockholm: The Radium Treatment of Skin Cancer.

From the Material of the Radiumhemmet.

1,600 skin cancers have been treated at the Radiumhemmet up to and including 1929. It has been possible to control, with very few exceptions, the results of treatment in these cases. A histological classification along modern lines has been carried out on at least 700 cases. The material thus classified has been studied with regard to the following questions: 1) Does there exist a difference in the radiosensitivity of the various histological tumor types, of such significance as to indicate a difference in the technique of radiological treatment? 2) Which of the two methods of treatment, interstitial implantation or surface application gives the best results? The material shows that except for Darier's »Type intermédiaire» there is no difference of practical significance in the radiosensitivity of the different histological types of tumor. The tumors of the intermediary type show a great tendency to recur and to produce metastases which seem to be remarkably radiosensitive. Therefore in cases of this type the primary tumor should be treated with a wide margin and the lymph node regions should be radiated whether metastases can be demonstrated or not. Interstitial implantation is best suited for skin cancers whose limits can be exactly determined on examination and considerably better results are obtained than with surface application. The better results with this method have not been won at the cost of cosmetic disadvantages. The poorer results with surface application are chiefly due to movement of the applicator during the treatment. All the cases have been observed at least 3 years after the first treatment. 90 % of the cases have become symptom free and 3 year cures have been obtained in 76 %.

Discussion:

I. Jens Nielsen: In addition to Dr. Magnusson's report on the results of treatment of skin cancer at the Radiumhemmet, it may perhaps be of interest to see the statistical results of the Radium Station in Copenhagen. The treatment of skin cancer illustrates in nuce and in a very pregnant way some of the fundamental problems in the radiation of epidermoid carcinomas.

I have recently gone over our material and the report I gave to the Danish Radiological Society two months ago is now in press, therefore I can refer to details therein.[1] The subject was that of all the skin cancers treated from 1920 to 1928 (Table 1).

Since the term »cancer of the skin» covers so many lesions varying in extent, depth of growth, localization and malignancy, I have considered it best in my report to follow the standard set by Winter for cancer of the uterus (i. e. 5 year results on all cases). Thus there will gradually be a possibility of reaching comparable results.

[1] Ugeskrift for Læger 1933, p. 464 and 723.

Table 1

Epitheliomas treated with radium 1920—1928, Radium Station, Copenhagen

Number of cases	277
Symptom free for at least 5 years	139
Absolute cures	50 %
Relative cures	52 %
1. Deaths from other causes, symptom free <5 years	13
2. Alive with cancer >5 years	25
3. Could not be traced, <5 years	5
4. Deaths with cancer <5 years	71
5. Recurrence after radium treatment, then treated again with radium, symptom free <5 years after last treatment	1
6. Recurrence after radium treatment, then given a different type of treatment	13
7. Untreated (kept under observation)	1
8. Untreated or abandoned treatment	9

(Tables 2 and 3). In these tables I have tabulated the results of various authors and as one can see, the statistical treatment of the material is very variable (see HINTZE and BILLROTH). It is highly desirable that we obtain standard statistical norms to follow.

All of these cases have been primarily treated with radium only, usually by means of surface application. Combination therapy has not been used.

There are of course many points that would be interesting to discuss if time permitted but I shall content myself by presenting only a few.

Table 2

Results of the different authors with different treatments

Statistical treatment of the material	Form of therapy	Place	Year	Author	Number of cases	Number of complete cures	% of cures
5 years	Radium	Radiumhemmet. Stockholm	1910—1915	FORSSELL[3]	207	142	69 %
	»	»	1921—1926	BERVEN	415	376	90.5 %
at least 1 year	Radium and Röntgen	Radium Institute, Paris	1919—1925	REGAUD[4]	100	72	72 %
5 years	Radium	Wien	1912—1925	ARZT and FUHS[5]	330	243	73 %
1/2—11 years	Intensive Röntgen	Zürich	1921—1926	MIESCHER[6]	321	298	92.8 %
?	Röntgen	Finsen Institute, Copenhagen	?	REYN[7]	322	202	62 %
	Operation	»	?	»	90	87	96 %
5 years	Radiation (Röntgen?)	Röntgen-Radium Institute, Berlin	1921—1931	HINTZE[8]	216	85	39.4 %
	Operation	»	1921—1931	(BIER)	171	69	40.4 %
(NB. Only cancer of the face) 3 years	Operation (without antisepsis)	BILLROTH, Wien	1867—1876	v. WINIWARTER[9]	166	67	40.1 %

Table 3

Total number of recurrences	109
Number of recurrences in, $^1/_2$ year	59
$^1/_2$— 1 year	21
1— 2 years	14
2— 3 years	4
3— 4 years	3
4— 5 years	3
5— 6 years	1
6— 7 years	3
11—12 years	1

Table 4

Of the 139 symptom free,

24 (= 18 %) were referred to the Radium Station after they had had röntgen radiation (usually several times).

115 (= 82 %) were referred directly without having had any previous treatment.

Of the 138 which recurred or did not heal,

67 (= 49 %) were cases which had previously been röntgen-radiated

and only

71 (= 51 %) had not been previously treated.

Table 5

Of the 139 symptom free,

106 were treated once	76 %
29 were treated twice	21 %
4 were treated 3 or more times	3 %

Table 6

During 1920—21, 34 of the 56 cases had had previous radiation.
During 1931, 14 of the 101 cases had had previous radiation.
During 1920—21, in 56 cases the condition had been present before consultation

$<$ 1 year in 5 cases
$>$ 1 year in 51 cases.

During 1931, in 101 cases the condition had been present before consultation

$<$ 1 year in 29 cases
$>$ 1 year in 73 cases.

The primary results (1 year) for these reasons alone may be better.

Epithelioma	1931	1920—21
Number	101	56
Symptom free (at least 1 year)	91	27
Symptom free $<$ 1 year, death from other causes	4	1
Not symptom free	6	26
Unknown fate	0	2

1) The time of recurrence (Table 3).

2) The influence of previous radiation on the results of later radiation treatment (Table 4).

3) Following logically, it becomes a matter of obtaining freedom from symptoms with one treatment or one series of treatments (Table 5). As long as the cancer is still virginal, untouched by rays, one has a chance. It can be distinctly seen from our material that this conception has gained ground in Denmark during recent years (Table 6). The number of verified cases of skin cancer is steadily increasing. In addition the cases are being discovered earlier and the primary results are consequently better (Table 6).

Table 7

	Number o cases	Symptom free 5 years
Cornifying squamous cell	66	27
Basal cell	80	43
Mixed types (difficult to classify)	11	5

Table 8

	Number	Symptom free	Not symptom free 5 years	Death <5 years
Relatively small (coin-sized), not infiltrating cartilage or bone	114	*)	24	19
Large non-infiltrating epitheliomas (vegetative, projecting or flat, creeping)	51	30	21	13
Epitheliomas with infiltration of cartilage or bone	107	19	88	51

The relation between the histological picture and radiation-sensitivity is still of course an unsolved question, even in the field of skin cancer where conditions are the simplest (Table 7). It may be mentioned at this point that we have paid no attention to the histological picture in our plan of radiation.

In our final report we desired to adhere to a strict statistical standard (Table 1)— but that has not prevented us from treating the material in such a way that the figures, without any doctoring, give a clearer picture and do not thereby lose in accuracy. It is of course the infiltration which is the deciding factor in the healing possibilities.

(Table 8)

1) Excluded 18 because of death from natural causes. Cures = 90 out of 96 = 94 %.

2) Excluded 8. Cures = 30 out of 43 = 70 %.

3) Excluded 17. Cures = 19 out of 90 = 21 %.

The question of carcinoma terebrans and the best method of treating such types cannot be gone into here. I will merely say that apparently one has only three choices, *distance treatment with radium according to Berven, protracted fractional röntgen treatment according to Coutard's principles* or *observation* with purely palliative local treatment without radiation.

Neither can I go further into the matter of *combination treatment* which doubtless has some advantages. It seems to me that the greatest danger is that one is prevented from using to the full any one of the remedies in the combination, be it radiation, surgery, or electroendothermy.

Finally table 9 shows the causes of death in cases of skin cancer. Local invasion is the most frequent cause and it is usually followed by meningitis. Lymph node metastases are most frequent with carcinoma of the extremities.

I cannot do more than mention the various localizations and special forms; cancer of the eyelid, the external ear, cancer of the extremities, wound cancer, fistula cancer, lupus cancer, lupus erythematosus cancer, radiation cancer, occupational and therapeutic cancer, acute skin cancer, secondary cancer and the precancerous lesions.

Table 9

Cause of death	No. of cases	< 1 year	> 1 year	
Local extension of the cancer . .	16	5	11	C. nasi 7 (out of 84) C. auris 3 (out of 16) C. palpebrae 3 (out of 38) C. genae 2 (out of 46) C. manus 1
Lymph node metastases	5	2	3	C. extrem. inf. 2 C. extrem. sup. 2 all cornifying C. auris 1
Erosion and hemorrhage	5	2	3	C. region. temporalis 4 C. genae 1
Pulmonary metastases	2	1	1	C. nasi (cornifying)
Cachexia	1	—	1	C. capillitii (basal cell)
Death in connection with a later operation	2	2	—	
Suicide	1	1	—	
Pneumonia	8	2	6	
Heart failure	5	3	2	
Apoplexy	3	2	1	
Nephritis	1	—	1	
Cancer of the oesophagus	1	1	—	
Carbuncle on the neck	1	—	1	
Unknown cause	33	2	31	

In conclusion I should like to mention protracted fractional röntgen treatment of skin cancer. It has been used for 2 years at the Radium Station in Copenhagen partly under the same conditions as deep therapy, 175 kv. Thorœus filter with a long skin-focus distance and intensity 2–4 r per minute, and partly with the same low intensity but with a suitable decrease of secondary tension, milliampères, skin focal distance and filter, for example 100 kv., 2 m. a., 3 mm. Al $^1/_2$ Cu and 40 or 30 cm. skin focal distance.

The primary results are very encouraging and seem decidedly better than with simple fractional treatment. We are therefore continuing with this method in selected cases but the treatment is time consuming and expensive from an economical standpoint. We cannot decide from the clinical results whether the quality of the rays plays a large rôle or not but we have the *impression* that the course is milder with radiation of higher tension and heavier filtration even when the intensity in röntgens per minute is the same.

(Now that it is possible with Metalix and Tutohaube to give treatments with a shorter skin-focus distance it would be interesting to carry out a series of experiments in which the skin focal distance were short and the tension not decreased, but where one kept the intensity per minute low by a decrease in milliampères and heavy filtration (with lead for example). In this way the depth dosage for these superficial conditions would become more rational.)

II. LARS EDLING: I should like to ask Dr. MAGNUSSON about some things which seem to me to touch on important questions for all those who have to do with the radium treatment of skin cancer.

1) What is the experience at the Radiumhemmet with skin cancer growing immediately over bony prominences, for example, in the frontal or mastoid regions, and what is the result of interstitial implantation compared with surface treatment?

2) I wish to ask the same question with regard to tumors which grow over cartilage of, for example, the ear and nose.

3) Are there any definite experiences regarding the differences in prognosis in radium treatment of skin cancer on the face and on the extremities and trunk, which have been illustrated by the material of the Radiumhemmet?

III. W. MAGNUSSON: In answer to Dr. EDLING's questions:

1) With regard to localization of skin cancer on the face, those tumors which are situated on the ears and nasal alae have a worse prognosis because they infiltrate earlier and tumors on the trunk have a worse prognosis than those on the face because they are usually considerably larger when they first come to treatment.

2) For superficial tumors of the nasal alae and ears, interstitial radium implantation is often used with good results and without extensive resulting necrosis. Coagulation or teleradium are most often used for infiltrating tumors.

IV. S. A. HEYERDAHL: I have asked Dr. BULL ENGELSTAD to explain the method of radiation of skin cancer in the Norwegian Radium Hospital. Although the hospital has not been in operation more than 1 year it may be of interest to hear how the treatment is carried out at present in the various cancer centers of Scandinavia.

The senior radiologists will remember that I reported the first case of interstitial implantation of skin cancer in Scandinavia (Nordiska F. f. M. Radiol. 1921 Copenhagen). Since that time I have used interstitial implantation with radium a great deal in the Radium Department of the Rikshospitalet. Since I have taken over the Norwegian Radium Hospital we have gone over to surface treatment as the chief method combined with teleradium treatment and in exceptional cases interstitial implantation.

V. ROLF BULL ENGELSTAD: I shall discuss in brief the methods we use in the treatment of skin cancer in the Norwegian Radium Hospital. Our chief method has been radium treatment with surface applicators either alone or along with teleradium, electrocoagulation or interstitial implantation.

In our surface application treatment we use a skin-focus distance of 0.5—3.0 cm. and a filtration of 1 to 2 mm. Pt. The daily dose has varied between 4 and 10 D and the total dose has averaged 55—60 D over an average treatment time of 6 days.

Altogether 58 cases have been treated. Five of these for one reason or another have received incomplete treatment. Out of the remaining 53, 42 are free from symptoms, 3 very advanced cases are improved and 2 are dead, one of intercurrent sickness. In 6 cases records are lacking.

I want to call attention to the fact that almost 50 % of our material is made up of recurrences after operation or radiation.

VI. GÖSTA FORSSELL: For the evaluation of radiotherapy in a certain type of tumor, for example spino-cellular or basal cell cancer of the skin, it is necessary to distinguish clearly between the radio-sensitivity and the radio-curability of the tumor. As I have previously pointed out, the most radio-sensitive tumors on account of their clinical character are often to a less extent radio-curable than less radio-sensitive more slowly growing tumors which remain locally limited for a longer time. Radio-sensitivity is an important factor but in most types of cancer it is sufficient to bring about a local cure if the entire tumor is accessible for radiation.

The clinical character of the tumor, its size, its topographical position, its method of growth and above all its tendency to spread and to metastasize are the deciding factors as to its radio-curability or the possibility of bringing about a permanent cure.

I further beg to call attention to the fact that when it is a matter of determining the value of different methods of radiological treatment, great weight must be laid upon the treatment time needed. We know that in many forms of tumor, for example in skin cancer or cancer of the lip, a permanent cure can be obtained with at least as great certainty by a short treatment time of a few hours as with protracted treatment, if suitable technique and dosage are used. In the radio-therapeutic clinic it plays an important part whether the patient can be treated in the out patient department or whether he takes up a bed for a few days or whether an expensive and much needed place will be occupied for a long time, not to mention the economic importance to the patient if he can receive his treatment quickly. It is not in the least desirable to treat for days or weeks a tumor which can just as well or even better be cured by a few hours radiation.

It can not be right on account of theoretical speculations to protract a treatment which according to practical experience can produce just as good results when given in a short time.

II. E. Berven, Stockholm: The Technique used at Radiumhemmet in the Treatment of Tumors of the Oral Cavity.

III. Lars Edling, Lund: The Primary Results of Radiological Treatment of Cancer of the Hypopharynx and Larynx at the Radiological Clinic in Lund.

The author reports the primary results of treatment in 13 cases of cancer of the hypopharynx and 9 cases of cancer of the larynx during 1929—32 at the Radiological Clinic in Lund. The technique has not been uniform because it has been in a state of development but it has usually consisted of teleradium radiation. Cases with very severe changes or a bad general condition have only been given röntgen radiation. The amount of radium at our disposal was at first only 400 mgm. which was increased in 1930 to 1,200 mgm., obtained from the Jubileum Fund of Gustaf V. During the first part of the period in question, treatment was given with an apparatus constructed by the author and later with SIEVERT's new apparatus. Nowadays 70—90 gram hours are usually given, divided in 4—6 fields around the neck. The total time period is about 3 weeks, with 2 treatments of 2 hours a day.

Among the hypopharynx cases, 3 who were treated only with röntgen (for the reason given above) died within a short time. Two cases with metastases received combined treatment and the primary tumor healed but both patients died, one of metastases, the other probably of perichondritis. Of the remaining 8 cases which received only tele-

radium, 3 are at present symptom free, the others have died either of recurrence or from direct progression of the tumor. Among the 9 cases of laryngeal cancer, 3 were recurrences after operation and they have died after a shorter or a longer period. Of the remaining 6, there are 3 symptom free after 17 months, 11 months (recurrence, coagulation, symptom free after 5 months) and 6 months respectively. In one case with large metastases, teleradium was given in combination with protracted röntgen with a good primary result, but later a recurrence appeared; the other 2 were only temporarily improved. In all of the latter 6 cases teleradium only was given.

The author discusses in conclusion the methods which are available to improve the results of treatment of this group of tumors and cites the advances made in HOLTHUSEN's clinic in Hamburg with protracted röntgen radiation.

Discussion:

I. JENS NIELSEN: I wish to discuss very briefly the technique of röntgen treatment which has been tried out for the last two years on tumors of the oral cavity in the Radium Station in Copenhagen.

I want to describe how the method has developed during this period, what difficulties and complications have accompanied it and how we have recently tried to follow the clinical röntgen dosage which COUTARD is himself experimenting with. I will only talk briefly about the results since Dr. JUUL reported the first results 1 year ago. The value of the primary results of radiation is relatively slight and the time period has been too short to allow of discussion of anything else than primary cure. I will therefore confine my discussion to the purely technical side.

Dr. JUUL began these experiments two years ago, based on the experiences of SCHINZ in *Zürich* and HOLTHUSEN in *Hamburg*, probably 2 of the most prominent German advocates of protracted röntgen radiation. At that time two years ago we were faced with the same difficulties as all other röntgenologists outside France in changing the valuation of the biological radiation dose from the Wintz-Pfahler skin-erythema concept to the French skin epidermitis and mucous membrane epithelitis. In clinical experiments we could only gradually and cautiously work up to the doses which in advance seemed too large and which produced the well known röntgen reactions which in the era of intensive therapy were the expression of the most extreme overdosage. As our clinical experience gradually increased and as we by personal observation convinced ourselves of the primary healing of these reactions, the doses were also increased to the amount necessary to produce the mucous membrane reactions which are considered necessary. There then appeared — as in all other clinics — a whole series of biological and radiological technical problems which took time to come to decisions about. There were the questions of the significance of the *quality factor*, secondary tension and filtration, and especially the question of the *time factor* which steadily engaged the attention of German röntgen therapy, »die einfache fraktionierte Bestrahlung» compared with »die protrahiert-fraktionierte Bestrahlung». At the same time as the doses increased, the local and general complications began to appear in larger numbers. We have gradually reached a somewhat clear if not final conception and, expressed in brief, the result is that for the last half year we have more and more applied a radiation technique in accordance with COUTARD's own principles, which deviate on several important points from the various German technical modifications.

Dr. BERVEN has pointed out on several occasions that »röntgen radiation» in accordance with *Coutard's principles* is an extraordinarily difficult task which requires much radiological technique, radiophysiological and clinical experience and knowledge and that it is a radical and dangerous treatment. We are in complete agreement with

Dr. BERVEN on these points. It seems to us, however, that we already have a somewhat better command of both the technique and the clinical complications.

It will certainly give the clearest conception of the fundamental principles of radiation and their practical application if I am allowed to sketch the so-called Coutard treatment as carried out by COUTARD himself.

I will begin by emphasizing that COUTARD's röntgen radiation during recent years is to be considered as a series of clinical röntgen radiation experiments on the epidermoid carcinomas of the oral cavity, pharynx and larynx with especial attention to the time factor. The important point in radiation lies in the *epithelitis*, the reaction of the epithelium, which is recognized clinically by the well known skin reaction and pseudomembrane formation on the mucous membrane. These are an expression of an elective destruction of epithelial tissue and a relative protection of connective tissue.

With certain standard radiation conditions: Kv., filter, size of fields and distance, the mucous membrane reaction appears at different times in the various parts of the oral cavity and pharynx, for example, on the tonsillar pillars in 14 days, on the posterial wall of the pharynx in 16 days, on the epiglottis in 18 days, on the base of the tongue in 20 days, on the endolarynx in 22 days and on the skin in 24—26 days. This chronology is an expression of the significance of the time factor.

The aim in radiation is to produce an epithelitis, a confluent continuous thin membrane over the tumor itself and on the mucous membrane which surrounds the tumor, with as few local and general complications as possible. In epidermoid carcinoma this membrane should last 10—14 days.

The radiation is first and foremost clinical and each case is treated individually with attention to the peculiarities of the patient. Not only the morphological and clinical structure of the tumor are considered but also the histological picture, the rapidity of growth, the infiltration accompanying mixed infection, the condition of the mucous membrane, the general physical condition and the subjective findings during treatment. From day to day the clinical dosage is decided with reference to the local and general condition and the previous treatment.

Each case must thus be considered individually.

In practice this means that a complete clinical examination is required for each treatment.

What line of procedure should one follow in practice with regard to the clinical dosage?

If the tumor is fixed or infected it requires cautious beginning doses given over a longer period of time (perhaps of anti-inflammatory effect). If the fields are large or there are bilateral lymph node metastases one must take the general condition into consideration (weight, bloodpressure, myocarditis, hepatitis etc.).

With regard to local lines of procedure, edema should not develop, the saliva should not become thick, the pseudomembrane should be thin and not thick or bleeding, and there should be no erythema of the skin. These all require that the dose should be reduced or the intensity decreased. One must manœuvre from day to day and from treatment to treatment.

If it is a matter of small fields as in an endolaryngeal cancer without fixation, one can force the treatment and produce a membrane in the course of 14 days, if the general condition allows it.

I want to stress the fact that the high tension (200 kv.) heavy filtration and long distance (protraction) are considered necessary as the elective effect is decreased with simple fractional treatment.

Altogether we have treated more than 100 patients with protracted röntgen radiation.

I shall illustrate how we have attempted to follow the clinical dosage in 3 cases of

cancer of the oral cavity because epidermoid cancer of the oral cavity is on the whole much more difficult to cure than cancer of the tonsils, pharynx or larynx (Photographs).

I hope that it is obvious from what has been said, what a difficult and time-involving problem a clinical röntgen radiation according to COUTARD is, and on how many points it differs from simple fractional or even protracted fractional röntgen radiation as a schematic dosage plan. The principles are both theoretically and practically interesting and they may embody possibilities for further effectivity in the treatment of epidermoid carcinoma, perhaps with an increase in secondary tension, if the so called electivity grows with an decrease in wave-length.

At the Radium Station in Copenhagen the clinical experiments with protracted röntgen radiation will be continued to as great an extent as working capacity and apparatus allows.

II. S. A. HEYERDAHL: In all radium treatments the measure of the dose in Dominici units. Sievert's apparatus, with which we are very satisfied, was used for the teleradium treatments. Cancer of the oral cavity is usually treated in the following way. First, protracted teleradium treatment of the lymph node and tumor areas is carried out and the patient is observed to see whether the tumor completely disappears. If it remains, interstitial implantation of radium is done and if this does not give the desired result, the oral tumor is operated upon by electro-surgery. With protracted teleradium treatment one attains a higher dose — we usually continue until we get a visible radiation reaction, »epithelitis», — and the patients are controlled continually during the treatment. For cancer of the hypopharynx and larynx Coutard's treatment is often used as it gives larger percentage depth doses and one can treat the diseased area more easily. It is desirable to use 2 or more portals. Up to 9,000 r have been used without danger in laryngeal cancer.

III. E. BERVEN:

IV. L. EDLING: With reference to Dr. BERVEN's presentation of the treatment of lymph node metastases of oral tumors I wish to ask him what dosage of teleradium it is customary to give in the Radiumhemmet in the preoperative treatment of such nodes. In many of my own cases I have obtained secondary rather than primary healing of the operation wound. It would be interesting to know if this is also a usual condition at the Radiumhemmet and what significance they attribute to such an outcome.

V. E. BERVEN:

VI. BJARNE DAHL: At the Radium Hospital in Oslo the same principles are followed as at the Radiumhemmet in Stockholm; first teleradium and then operation if the result is not satisfactory. I have carried out a series of about 20 cervical lymph node resections according to the method of ROUX-BERGER, after preceding intense teleradium treatment. In every case the field of operation had been the seat of an epidermicidal reaction with a moist desquamation of the skin. The wound healed in a normal way in every case.

VII. ROLF SIEVERT: Referring to Dr. HEYERDAHL's contribution regarding dosage in teleradium treatment, I should like to mention the unit we have made use of in Sweden — the so called Imc unit. We find it suitable because both measurements and calculations can easily be made with it. It is an intensity unit which is defined as that intensity existing at a 1 cm. distance from a preparation of radium (so small that it may be considered as a point) containing 1 mg of radium element and surrounded by a standard filter. The dose is given in Imc hours. With our radium apparatus a

maximum of 6—700 Imc hours is given to one field. If in radium treatment one can speak of an HED at all, as biologically comparable with an HED in röntgen treatment, one should be able to say that about 500 Imc hours correspond to an HED. One Imc hour is approximately 7 r and therefore 500 Imc hours are about 3,500 r, which coincides rather well with the 3,000 r figure given by Dr. JACOBY.

IV. Paul Jacoby, Odense: Teleradium Treatment with One Gram of Radium.

The author discusses his experience with this form of treatment at the Radium Station in Odense which for the time being is the only city in Denmark where it is extensively used.

The treatment was introduced in January 1930 but has only come into extensive use during the last $1^1/_2$ years. The station's available supply of radium is from 700 to 1,000 mgm. The author has constructed his own apparatus (canon) which he describes. Careful investigations of the limitation of the field and spreading of the radiation from the apparatus are mentioned, as well as studies on the depth distribution of the radiation which show the inapplicability of this form of treatment for conditions situated deeper than 4 to 5 cm. Without expecting the measurements to be generally applicable the author has determined the intensity of the radiation in r units and the approximate values for the r-minute at a distance of 2—10 cm. from the skin. He has found that the intensity approximately corresponds to that which is preferably used in the Coutard röntgen treatment and also that the two methods very much resemble one another in effect etc. The results on 91 patients are reported, showing in which cases treatment is indicated and where one can hope for a good primary result.

Discussion:

I. ROLF SIEVERT: With regard to Dr. JACOBY's reference to the limitation of the field in the teleradium apparatus described, I want to point out that in the construction of the Radiumhemmet's apparatus for distance treatment, we have not attempted to attain as sharp a limitation of the field as possible. A too sharply limited field is accompanied by certain inconveniences. When several fields are treated and they do not lie sufficiently close to one another, one obtains a non-radiated zone between them. If on the other hand two fields cover one another at the edges there is great danger of overdosage. At the Radiumhemmet we have therefore tried to obtain such a distribution of radiation that a relatively constant amount is received in the middle of the field and its borders are sufficiently diffuse to avoid as much as possible the risks just mentioned.

V. Bjarne Dahl, Oslo: The Effect of Röntgen Radiation on the Growth of the Young Tubular Bones.

The lower half of the femur and the upper half of the tibia of young rats have been radiated with a dose which practically corresponds to REGAUD's epidermicidal dose. The following observations were made with the help of röntgen photographs and macroscopic examination of the specimens.

1) A quickly commencing elucidation of the marrow cavity is produced, with resorption of the bone marrow.

2) Distinct calcification of the radiated metaphyses and epiphyses.

3) Devascularization of the metaphyses, epiphyses, periosteum and cortex. This was observed some days later than the calcification.

4) The growing epiphyseal cartilage is very resistent to röntgen radiation while the proliferation in the epiphyseal discs can be completely stopped at an early stage.

5) Endochondral and periosteal ossification can be stopped at an early stage. The röntgenological picture of the tibial and femoral metaphyses is very characteristic where this effect is obtained.

On the other hand, a new formation of bone which continues after the radiation, has been seen in the epiphysis and sometimes in the diaphysis. The röntgenological picture of bone centers in the tibia is characteristic.

6) The normal reformation of the bone structure is missing. No normal spongiosus structure appears.

7) Progressive resorption of the diaphysis.

8) Constantly appearing spontaneous fractures. No callus forms, the fragments are resorbed.

9) Attention is called to the peculiar form of the ends of the diaphyses and the diaphyseal surface of the epiphyses of the femur. The radiated epiphysis of the femur develops normally and has a normal shape. This also holds good for its diaphyseal surface in spite of the fact that the corresponding end of the diaphysis is not developed and the normal pressure from this side is missing. This seems to be in support of the autonomic development of the skeletal parts.

VI. R. Sievert, Stockholm: Some New Fields of Application for the Condenser Chamber.

The condenser chamber method worked out in the Physical Laboratory of the Radiumhemmet has been further developed. The speaker mentioned some of the results and described some condenser chambers intended for special purposes.

Radium measurements by mail have shown that if 3 condenser chambers are exposed to each radiation which one wants to determine, an accuracy of $\pm$ 2 % can be counted upon in most cases, even if the time between charging and reading is extended up to $1^1/_2$ months.

In this laboratory Dr. BENNER has designed a new chamber whose ionized volume is only about 2 cubic mm. and which is intended to be used for measurements in the tissues, especially in interstitial implantation with radium needles.

The application of the method for measuring radiation in röntgen therapy has been tested and a chamber has been worked out which is nearly independent of the wave length and gives such exact values that with simultaneous exposure of 2 chambers the risk of an error of more than $\pm$ 5 % is 0.5 %. The chamber is 2 cm. long, $^1/_2$ cm. in diameter and can be used in the range 10—600 r.

The method can also be used for the determination of the radium content in such radioactive minerals as can be of value in the production of pure radium.

Finally a chamber construction for extensive measurements of the natural radiation (gamma as well as ultra radiation) was demonstrated. This chamber allows investigations of the distribution of radiation in different places to a much greater extent than was possible with previously available instruments.

Discussion:

I. N. H. MOXNES: When measuring the dose of radium radiation we have no agreement of using the same unit in the various countries as we have in röntgen radiation.

At the opening of the Radium Hospital it was decided to use for the unit of dosage, a Dominici as defined by MALLET and COLIEZ and their micro-ionometer as the measuring apparatus. The apparatus was on the market and the method had been tested out by MALLET over a long period of time. At the beginning of the hospital's activity it was therefore very convenient to use this method to get a quantitative measurement of the radium radiation.

The method, the measuring apparatus and the unit are in principle the same as that used at the Radiumhemmet by Dr. SIEVERT. The apparatus is a small chamber of aluminium, 1 cc. in size, which serves at the same time as an electrometer. The unit of radiation is attained by a tube with 10 mg. radium element placed 20 mm. from the inner wall of the chamber or 26 mm. from the center. The filter is 2 mm. of Pt. A Dominici (1 D) is obtained with a 10 hour duration of this radiation. Thus in 24 hours the »Debit Journalier» is 2.4 D.

After adjusting the apparatus and determining the discharge time t_e of the electrometer, the dose is measured, on for example a surface applicator, by placing it over the chamber at the distance where it is desired to determine the dose and the discharge time t_x is measured again. The radiation time is then the ratio between these two figures multiplied by 2.4

$$\text{Dose} = \frac{t_x}{t_e} \times 2.4$$

The measurements can be carried out quickly. All the holders such as surface applicators, teleradium apparatus etc. are measured with this method and the treatment time is estimated in accordance.

The Imc hour unit used at the Radiumhemmet is of the same type as a Dominici. I am investigating the relation between these two units and my temporary conclusion is that

$$1 \text{ D} = \text{about } 11.6 \text{ Imc hours}$$

This is the case with the condenser chamber above mentioned. Perhaps the relation will be somewhat different for chambers of another size.

MALLET's method with fixed chamber is usable and practical for a number of things even if it is not as generally applicable as movable chambers. Since Dr. SIEVERT's introduction of movable chambers MALLET has also introduced movable chambers but adjusted in Dominici units. These are not used at the Radium Hospital.

It seems to be probable that as long as there is no accepted international unit for radium as there is for röntgen radiation and as long as the use of the röntgen unit is not experimentally worked out for practical use in radium, that the northern countries could agree on the use of the same unit and the same method. Then one could directly compare the measured doses and the results of treatment in the various countries. The difference in the units is only a simple factor and it may be easy to come to an agreement.

It will therefore be interesting to hear what the representatives from Denmark have to say.

II. R. SIEVERT: Referring to Dr. MOXNES' discussion, I would like to point out an essential difference, not mentioned by him, between the French D unit and the Imc used at the Radiumhemmet. The Imc unit is not like the D unit, a dose unit but

an intensity unit. In radiation treatments where the time of treatment varies tremendously it is desirable that those concerned should also have to state the radiation time. One must realize that there may be a time factor which is of possible significance in the result of treatment and which still further favours the choice of an intensity unit.

It would be very valuable if the Scandinavian countries could agree on one and the same unit so that the results of our treatments at least could be compared with one another. One still very often sees doses reported in milligram hours which in itself is no unit of dosage unless accompanied by an exact statement of the form and position of the radium applicator. I am convinced that these reports in milligram hours are the cause of many misunderstandings and it is highly desirable to avoid the use of this term.

III. S. A. HEYERDAHL: Ever since we opened the Norwegian Radium Hospital we have considered it important to measure all our röntgen and radium doses. At present we are measuring all the surface radium applications in Dominici units (except radium applications in the uterine cavity and vagina) so that we can completely leave the milligram hour dose which is really a bad method and only valuable when one knows the type of filter and distance.

IV. P. FLEMMING-MØLLER: Since there is no one present from the Radium Station in Copenhagen or the Finsen Institute, I will merely say with regard to Dr. MOXNES' question that one should consult Dr. JUUL at the Radium Station and Professor H. M. HANSEN who are our advisory Physicists.

VII. R. Thoræus, Stockholm: Current Problems of Dosage in Swedish Röntgen Therapy.

The author submitted the results of his measurements regarding the relation between the international *r*-unit and the skin unit dose, HED, as used in Swedish röntgen therapy. This HED refers to an irradiated field A measuring 10 × 10 cm and is emperically determined by biological tests.

The measurements were carried out for all the radiation qualities used in therapy both on a wax-phantom and during different treatments. The dosage values obtained on the phantom, for each quality and for different fields A, were collected in tables. In comparing the dosage-values obtained during the treatments with the corresponding values in the tables the deviations were found to lie within about ± 5 %.

The close collaboration established in 1925 between the Physical Laboratory of the Radiumhemmet and the röntgen therapy departments of the Swedish hospitals has made it possible to maintain a very constant HED-dosage. Because of this one can now by means of the above mentioned tables, convert into *r*-units the dosage conditions in the Swedish röntgentherapy.

A more detailed account will be published in this periodical.

VIII. Sven Benner, Stockholm: Radiation Measurements on the Personnel Engaged in Radiological Work.

With the help of SIEVERT's condenser chamber method 50 protection measurements have so far been made, 33 in the diagnostic and 17 in the röntgen therapy departments. The latter series will be continued. The persons studied, carried for 1 to 3 days during their usual work, 12 small chambers — 10 mm. in diameter — distributed over the body

according to a definite scheme which differed for the diagnostic and therapy departments. As a rule 3 measurements were made on each person in order to eliminate chance errors.

There was a marked variation in the measured doses but they seldom exceeded the generally accepted tolerance dose of 0.2 r per day. The relation of the doses to the amount and arrangement of the work, to the protective arrangements and individual conditions was discussed. Even if certain conclusions can be arrived at, some of which were probable a priori (in the diagnostic clinics the nurses get small doses; the doctors receive radiation chiefly on their hands, which doses can be decreased by the use of protective gloves; in the therapy clinic the nurses receive radiation mostly from in front) such a number of different conditions affect the result that the measurements under discussion cannot be applied to other similar cases without direct measurements there as well.

Discussion:

I. N. H. MOXNES: Dr. BENNER's work is of the greatest value in the important question of protection from radiation. Condenser chambers allow one to really measure the radiation the staff receives.

This question has also been taken up at the Norwegian Radium Hospital. As far as röntgen is concerned we have the modern protected radiation tubes and none of the staff should be in the room during the treatment. As for radium we have carried out methodical protection, but one cannot shield oneself completely. The radiation around Dr. SIEVERT's apparatus was measured and found to be very small in amount. It would be interesting to hear the Swedish results of measurement around the apparatus.

II. SVEN BENNER: Just as Dr. MOXNES describes for Norway, the persons I experimented with have also been shielded by protective walls. The patient lies alone in the treatment room but the nurse sometimes opens the door for some reason and thus receives radiation. Measurements on the nurses working with the radium apparatus have not been carried out except the series discussed by SIEVERT.

III. R. SIEVERT: With regard to Dr. BENNER's answer to Dr. HEYERDAHL's question as to the risk of radiation from the radium apparatus, I wish to point out that the statements in my paper on the condenser chamber method (published in the spring of 1932) refer to the old apparatus at the Radiumhemmet and not to the newest model which is also used at the Radium Hospital in Oslo. On the last model we have placed all the wheels for adjusting the apparatus just as far from the source of radiation as possible and therefore the risk of radiation with this type should be considerably less.

IV. S. A. HEYERDAHL: At the Norwegian Radium Hospital we have nowadays good protection for the nursing personnel as we use radiation-protected röntgen tubes exclusively and the personnel is in the radiation-protected room outside the röntgen room, where the patient remains alone during the treatment. It can, however, happen that nurses go into the röntgen room for a short time and thus receive some secondary but no direct radiation. Our radium room and the way we protect our personnel from radium radiation are sufficiently described in the report from the Norwegian Radium Hospital.

V. N. H. MOXNES: We use the rule with SIEVERT's apparatus that it shall either radiate directly down to the floor or that if it is tilted it points in the direction of the outer wall.

VI. P. FLEMMING-MØLLER: It is an extraordinarily important question Dr. BENNER has discussed and I want to ask 1) if the doses which he measures on the personnel are not rather large although Dr. BENNER considers that they are small and 2) if Dr. BENNER has measured how much secondary radiation one gets from the one place of treatment to the other when one uses a 2 tube apparatus. I am thinking of the eventual addition of the secondary radiation the patient receives from the other place of treatment.

VII. SVEN BENNER: Measurement of the radiation which comes in on one side (with a two-tube apparatus) when the other tube is running has not been done. It is exceptional and should not occur that any of the personnel exposes himself to such radiation. Doses above the generally accepted limit of tolerance of 0.2 r per day happen rarely in diagnostic work; in röntgen therapy this was the case with only one of the persons examined and there was a special accidental reason.

IX. Gösta Forssell, Stockholm: Further Observations on the Mechanism of Movement of the Gastric Mucous Membrane.

The author presented a systematic account of the macroscopic high relief and low relief and of the miscroscopic relief of the gastric mucous membrane, illustrated by photographs from nature and diagramatic sketches.

The author has succeeded in observing and photographing, in the surviving stomachs of dogs during the digestive stage, the very same formations of the mucous membrane which he had previously described in fixed surviving stomachs and he has also been able to observe the movements by means of which the receptacles of digestion are formed. The mucous membrane *macro-relief* described by the author in 1913 and based upon observations on dead material, has been confirmed in all essentials, as well in regard to morphology as types of movement and mechanical function. In many respects the *micro-relief* shows the same form and types of movement as the macro-relief and the membrana propria and the membrana epithelialis have a finely differentiated mechanism of movement which allows the mucous membrane to vary markedly in thickness and which permits every section of the epithelial relief to change from a plane surface to a highly developed and complicated system of folds according to the needs of digestion.

X. Åke Åkerlund, Stockholm: The Anatomical Basis of the Röntgen Picture of the so-called "Acquired Hiatus Hernia".

1) The author reports that both *the name* (oesophageal) »hiatus hernia», suggested by him in previous papers, and *the subdivision of these hernias* have been largely adopted in röntgenological literature: (Group I: congenital shortening of the oesophagus, Group II: para-oesophageal hernia in the real sense, Group III: abdominal portion of oesophagus participating in the hernia, this group being nowadays considered »acquired»).

2) For the purpose of röntgen examination there are *two ways in which the contrast material may fill the hiatus hernia*, a) from below, proximately from the stomach, a coarser and simpler method, which is, however, sufficient for the more marked clinically important cases, b) from above, directly from the oesophagus, a more subtile method, which with sufficient experience allows the demonstration of the very beginning stages of acquired hiatus hernia, the clinical significance of which is however, very much open to discussion.

3) With regard to *the normal anatomy of the oesophageal hiatus* the author first mentions the peritoneal relations. The hiatus area itself may be said to lie extra-peritoneally. The author further refers to the anatomical investigations of the last year in regard to the hiatus musculature, the normal movability of the oesophagus and the normal situation of the anatomical cardia which have been carried out by KOEPPEN and FRANK ANDERS and NEUMANN, whose work shows the untenability of the standpoint of SAUERBRUCH, CHAOUL and ADAM on these questions.

4) The author gives a presentation of the *mechanism of origin and subsequent development of the acquired hiatus hernia* based on the above mentioned anatomical investigations. Under the influence of manifold different causes, described in detail, there begins a visceral protrusion up through the hiatus. The abdominal portion of the oesophagus passes through first and then the adjacent portions of the stomach follow. This visceral protrusion in its very first stages assumes the character of a hernia without a hernial sack and only when the hernia has reached a certain size is there also a bulging of the peritoneum. The fact that there is in the beginning no peritoneal covering is according to the author no reason for naming the beginning visceral dislocation anything else than »hiatus hernia», or if one wishes, »small sackless hiatus hernia» (cf. ANDERS: »Hiatus insufficiency with formation of a bell-shaped epiphrenic cardiac recess» or »thoracic dystopia of the cardiac antrum» and NEUMANN: »Bulbformation», »Bulbus antri cardiaci»).

5) Röntgen examinations as well as special anatomical investigations made in situ in old individuals have shown that *small sackless visceral protrusions through the oesophageal hiatus* — thus the very beginning stages of acquired hiatus hernia — are so common in this material that they *can almost be called physiological changes of age*. Pronounced cases of acquired hiatus hernia with a hernial sack are naturally very much rarer but — according to agreeing röntgenological and pathological anatomical experience — considerably more common than has been believed.

6) With regard to the röntgen diagnosis of hiatus hernia SAUERBRUCH, CHAOUL and ADAM's categorical denial of the existence of acquired reducible hiatus hernia is rejected. The attempts of these authors to label as röntgenological misinterpretations the published röntgen pictures of acquired hiatus hernia are replied to.

7) The author gives a report of his autopsy material, so far obtained, of röntgenologically diagnosed hiatus hernia (8 cases). On anatomical examination all 8 were found to be real hiatus hernia with a hernial sack. At least 7 and probably all of these cases belonged to Group III that is to the acquired reducible type denied by SAUERBRUCH, CHAOUL and ADAM and not to the para-oesophageal type.

XI. Bengt Ihre, Stockholm: Röntgen Kymography of the Heart.

Experiences with the small Stumpf kymograph for one year in St Erik's Hospital were reported. The kymograph has shown itself to be an extraordinary complement to the usual röntgen examination of the heart, in that it makes possible a more refined diagnosis of heart conditions and a detailed study of the movements of the different parts of the heart. In the diagnosis of pleuro-pericardial lesions and pericarditis as well as in the differential diagnosis of aneurysm and mediastinal tumor it has been of invaluable help and sometimes the only examination method by means of which one could make the correct diagnosis.

A study of the kymogram material from St Erik's Hospital gave no support to the conception that the Stumpf division into two types of pulsation was of clinical significance. It was not possible to support Stumpf's assumption that the double peaks of the right auricle observed within the lower half of the right border of the heart were in

any way pathognomonic of heart disease. The author opposes the idea that one can draw any sure conclusions as to the topographical anatomy of the heart from the configuration of these peaks. The pulsations along the right auricle have caused especial interest and special experiments have been carried out which prove that the so-called auricular pulsations can vary considerably in extent in each case under different conditions. The defects in previous theories of the origin of the so-called auricular peaks are pointed out as well as the satisfactory explanation which has been obtained from the recently published cardiographic investigations of ZDANSKY and ELLINGER.

XII. C. G. Sundberg, Vänersborg: The Interpretation of the Normal Röntgen Kymogram of the Heart.

The author has investigated the conditions necessary for taking a kymogram which exactly reproduces the movements of the contour of the heart and he describes a röntgen kymograph with an arrangement for taking an electrocardiogram simultaneously. In animal experiments on dogs the movements in different parts of the heart, especially at the atrio-ventricular border, have been observed and registered (»base kymogram»). Changes in the orifices have been studied by sterometric measurements on röntgen pictures of the heart in situ, prepared with pieces of lead to give shadows. The röntgen kymogram of the human heart was analysed in comparison with simultaneously taken electrocardiograms and the interpretation of the aortic, ventricular and auricular kymogram was discussed.

Discussion:

I. J. FRIMANN-DAHL: The speaker showed kymograms from the Rikshospitalet Oslo and explained how these investigations with the kymograph were carried out during the last half year. It was pointed out that one could distinguish the individual chambers of the heart in a much safer way than before. Records of arrhythmia were shown. Flutter arrhythmia and pulsus trigeminus can be seen clearly. The observations of double aorta and the dilated ventricle in aortic insufficiency when dicrotism is present, were very interesting. The kymograph can also be of assistance in tumors of the mediastinum, aortic dilatation etc.

II. BENGT IHRE: The time limit for the speech made it impossible to go into each technical detail of the kymograph. Since Dr. SUNDBERG has pointed out some of the defects in the Stumpf kymograph and especially the very crowded curve which is obtained, I will mention that we very early were aware of these difficulties with this kymograph. In order to make possible more detailed studies of the movements of the heart shadow, the Järnh Electrical Co. under our direction has constructed a kymograph according to somewhat different principles. The screen can be exchanged so that the kymogram can be taken with varying slots and varying widths of lead lamellae. The speed of the fall can vary between 1, 2, 3 and 6 seconds exactly.

Dr. FRIMANN-DAHL pointed out that auricular fibrillation easily could be recognized on a kymogram. As I mentioned in my lecture, this is only possible in cases where the arrhythmia is distinguished by a marked irregularity with unequal contractions. We have seen many cases of slow fibrillation which showed a regular rhythm on the kymogram and distinct double peaks appeared. In these cases it was therefore impossible to diagnose the fibrillation kymographically.

III. J. FRIMANN-DAHL: I did not mean that the kymogram gives better information than the electro-cardiograph in arrhythmia. The best pictures show that the kymogram can illustrate in the finest way what the electro-cardiogram registers.

XIII. J. Frimann-Dahl, Oslo: Postoperative Röntgen Examinations.

These investigations have been going on during the last few years. First the postoperative movements of the diaphragm were studied in about 30 patients following abdominal operation. With the author's own technique the diaphragm was photographed in expiration and inspiration on the same plate. The movements of the diaphragm were markedly decreased in cases where there was meteorism or pain from the wound and especially when the incision was situated in the epigastric angle. These investigations were carried out at the suggestion of Professor JOHAN HOLST of the Surgical Department of the Rikshospitalet.

The next task was to study the venous circulation in the lower extremities since it was expected that a decrease in diaphragmatic movements would influence this circulation.

It was thought that one could determine the speed of circulation if one injected a contrast medium into the saphenous vein and then controlled the emptying by screening. Per Abrodil was used to obtain the contrast. It has been shown to be without local or general effect.

A considerable retardation of the venous circulation was found in the days immediately after abdominal operations. In single cases there were distinct signs of retrograde filling of the femoral vein from the saphenous. The normal venous current could be examined with this method. Very brisk emptying of the saphenous vein was found in ambulatory and especially in young patients and a certain slowing of the circulation in patients confined to bed and especially in older people.

When the lower extremities were raised 45° or actively contracted the speed of emptying was increased to a marked degree.

The author next took röntgen photographs of the lungs of patients during the days following an abdominal operation. Patients with lung emboli were studied especially. The photographs could be taken without the slightest inconvenience to the patients. The infarct itself could be demonstrated. The bulky exudate which follows could also be shown on the röntgen film. It simulated very closely the exudate in a usual pleuritis. In many cases these investigations were of great help in the clinical diagnosis.

One can study postoperative meteorism by means of röntgen photographs of the abdomen in the days directly following an abdominal operation. When there is no special complication from the small intestine or stomach the meteorism is confined to the colon which may be considerably dilated.

Discussion:

S. JUNGHAGEN: In most cases of operation on the chest, abdomen, joints and several other areas of the body, pneumatic changes of a temporary nature are produced in the respective organs. These conditions of pneumothorax, pneumoperitoneum and pneumoarthrosis etc. can be clearly followed on the röntgen screen. I myself have made postoperative röntgen observations on other areas, which I have not seen described in the literature and which I consider well worth mentioning in this connection.

The illustrations which I shall show are from cases of kidney operations. The first is a young girl upon whom a nephropexy had been done. The wound healed by primary

intention and she was up on the 10th day but on the 12th day she had a subfeverous temperature. In the röntgenogram of the abdomen one sees a large collection of gas in the left hypogastrium. An opaque meal was given and it was satisfactorily determined that the gas was situated retroperitoneally in the kidney fossa and the central, sagittally situated density within it, was considered an adhesion between the anterior and posterior wall of the wound cavity. At another investigation some days later, the cavity was half filled with fluid. The treatment was exclusively expectant, the gas disappeared and the patient became well.

Another case was that of a young man whose kidney was also not removed. The röntgen diagnosis was tuberculosis (there was rigidity of the renal pelvis and diminished secretion). At operation nothing pathological could be found. In röntgen examination 10 days after operation, when the primary wound was healed and the patient was up and about, a large gas-filled cavity was found lateral and anterior to the kidney. The contours of this cavity were absolutely distinct.

Similar pictures have also been seen in a number of other cases.

The chief reason I wanted to bring these cases out of the depths of obscurity is that, in the presence of marked incongruence between preoperative symptoms and operative findings, these observations can give rise to a false interpretation of the pictures and can lead a surgical collegue along the wrong pathway in his treatment. For one inexperienced or untrained in the field, the diagnosis can easily become intra-abdominal abscess formation or an intestinal loop filled with gas. The röntgenologist must seek further and find where this accumulation of gas is situated and must not be satisfied with a sagittal plate of the abdomen. For these cases the pictures are taken in profile and a thoroughly satisfactory examination of the intestinal tract with a contrast meal must be carried out so that one can determine the retroperitoneal situation of the air or gas.

In a subsequent publication I will refer again to these observations and to related questions.

XIV. Rolf Bull Engelstad, Oslo: Experimental Investigations of Lung Changes Following Röntgen Radiation.

The experiments were carried out on rabbits and this animal's skin tolerance was used as the basis for the dosage. These investigations have given the following information with regard to the skin tolerance: A röntgen dose of 1,700 r or less, given in one sitting produces no distinct skin reaction or epilation. Doses between 4,000 and 7,000 r, divided between 3 or 4 sittings with 48 hour intervals, have produced an epidermitis which did not last over 6 weeks. Much larger doses of 9,000 r and over, produce a marked skin reaction (which in one case however healed after 8 weeks) or lead to the animal's death in the course of 2—3 weeks.

This presentation concerns only the lung changes observed during the first 3 months after radiation and they may be summarized as follows:

One finds distinct changes in the lungs already 4—5 hours after a röntgen dose which is very small in comparison with the skin tolerance of the rabbit. These lesions consist of hyperemia, small hemorrhages and edema, considerable degenerative changes in the lymphocytes of the normal lymph follicles and some times changes in the bronchial epithelium. In some cases there is a beginning infiltration of leucocytes as early as this.

During the first 24 hours one may find considerable pneumonic infiltration without being able to demonstrate any organisms with the Gram stain.

The experiments show further that these changes which appear after such relatively small doses have not completely disappeared in 2 months since there is still a moderate sclerosis in the lungs at that time. With these doses the lymphocyte regeneration takes place in the course of 2—3 weeks.

The changes are considerable with doses which produce a röntgen epidermitis of about 6 weeks duration. Often a rather severe bronchopneumonia develops, especially from the 10th day on and in some cases it leads to the animal's death. In addition to the usual inflammatory cells there are rather large numbers of macrophages from the 20th to the 30th days and even later. With these doses the lymphocyte regeneration takes place in the course of 3—4 weeks. As late as 3 months after radiation, considerable lung changes are found in the form of sclerosis, inflammatory infiltration, accumulations of macrophages and changes in the bronchial epithelium (monstrosities with the arrangement and appearance of squamous epithelium).

Still larger doses of 9,000 r or more produce severe bronchopneumonia and purulent bronchitis which leads to death in many cases. In this group the inflammatory processes seem to set in seriously between the 10th and 20th day after radiation.

Examination 3 months after radiation shows an increased amount of connective tissue and considerable perivascular, peribronchial and bronchopneumonic infiltration. Enormous numbers of macrophages and numerous giant cells fill up large parts of the lung tissue. The bronchial epithelium is proliferating, shows definite monstrosities and in many places looks like multiple-layered squamous epithelium. Epithelial giant cells and cornification are present. Vascular changes are very slight. Neither could definite lesions in the elastic fibers be discovered.

A pleural reaction, exudative or adhesive, was obtained with doses under 7,000 r n only 2 of the 35 animals and with much larger doses in 6 out of 12 animals.

XV. Nils Westermark, Stockholm: Comparative Röntgenological and Anatomical Studies of the Bronchi Especially in Pulmonary Tuberculosis.

The author has carried out comparative anatomical and röntgenological studies on the bronchi in pulmonary tuberculosis. The bronchi of patients who had just died of this disease were injected with lipiodol or jodopin and röntgen-examined. The pictures obtained show the bronchial tree well filled with opaque material also by considerable accumulation of secretion in the trachea and larger bronchi. In some cases the lungs were fixed in situ and examined by serial sections. In this way there was obtained a good comparison between the röntgenological and anatomical findings. The bronchi and lung parenchyma were also examined microscopically. In other cases the röntgen examination was followed by a metallic injection of the bronchi so that a complete anatomical picture of the bronchial tree was obtained. The anatomical preparations in these cases corresponded very well with the röntgen findings.

No filling of the bronchial branches within the tuberculous area was obtained either on post mortem röntgen examination after filling the bronchi with a contrast medium or from the anatomical bronchial injections, although good filling of the whole bronchial tree out to the smaller branches was secured in the unaltered areas. The pathological anatomical examinations also showed a complete occlusion of bronchial branches within the tuberculous area in places corresponding to the obstruction to filling, demonstrated by röntgen examination. The bronchial branches as well as the peripheral bronchi, as far as one could follow them, were completely filled with purulent exudate or caseous necrotic granulation tissue or both.

Microscopic examination of the lungs also showed rather extensive pure atelectases around and between the tuberculous nodules. In these cases wide spread bronchial occlusion was also demonstrated in the adjacent tissue. It was not possible, however, to prove microscopically that those very bronchi leading to the atelectatic areas were occluded.

The fact that röntgen investigation, anatomical injection and microscopic examination all showed that the bronchial branches within the tuberculous area were occluded, seems to go to prove that the lung atelectases in tuberculosis are for the most part due to bronchial occlusion. Obstruction atelectasis should therefore be a particularly common complication in tuberculosis.

XVI. H. Mossberg, Stockholm: A Contribution to the Röntgen Diagnosis of Traumatic Changes in the Lung.

The author describes 3 cases of lung injury with hemorrhage into the alveoli and probably into the interstitial tissue as well. The röntgen picture taken immediately after the accident shows more or less confluent, speckled and cloudy densitys, resembling those seen by bronchopneumonia, which were completely resorbed in 2 or 3 weeks. Two of the cases were examined with the bronchoscope and hemorrhagic mucous fluid was found in the trachea and bronchi. One of these two cases died and the diagnosis was verified at autopsy. A third case was presented with a similar röntgenological and clinical picture.

Because of the absence of marked atelectasis and the presence of a relatively low temperature in these cases, the author considered that most of the röntgenological changes could be explained by the hemorrhages in the lung although naturally atelectasis could also be present and could contribute in some degree to the origin of the areas of density.

XVII. Gösta Jansson, Helsingfors: Röntgen Diagnosis of Papilloma of the Renal Pelvis.

After a brief description of the clinical symptoms in these rare papillomas of the renal pelvis, the author describes the changes in the pyelogram in two cases observed by him. In the first there was a diffuse papilloma in the kidney pelvis giving rise to multiple filling defects in that region. In the other there was a plum-sized pelvic papilloma which hung down into uretral orifice and gave rise to a spindle shaped shadow with an inner net-like structure corresponding to the nodular surface of the tumor. There is a third type of pyelogram of renal papilloma described in the literature. The papilloma is smaller in extent and has a broad base. The author concludes by calling attention to the importance of pyelographic investigations in tumors of this type and he stresses the value of a greater röntgen diagnostic knowledge in this field.

Discussion:

H. Hellmer.

XVIII. Folke Knutsson: "Limy Bile."

The author reports 12 cases of »limy bile» all of which were operated upon. The gall bladder contained an amorphous deposit of calcium chiefly in the form of calcium

carbonate. These masses of lime are fluid, semi-solid or solid in consistency and the colour varies from whitish to dark brown. The author suggests these limy contents of the gall-bladder to be named »limy bile» as distinct from the previously used term »calcium-milk» (VOLKMANN) and »calcium carbonate stone» (PHEMISTER). Limy bile gives rise to an intensely dense gall-bladder shadow which should not be confused with normal opaque filling in cholecystography. As a rule the gall-bladder also contains an hydropic clear bile in which the limy bile sediments to the bottom. This double gall-bladder content appears clearly on pictures taken in an erect position as the limy bile shows a horizontal upper level.

Cholesterin stones have been found in all cases and appeared as filling defects in the limy bile or as a result of a calcified structure of the nucleus or superficial layer. A stone was most often found wedged in the cystic duct. On microscopic examination the gall-bladder wall showed chronic inflammatory changes and hypertrophy of the musculature.

In conclusion the possible causes of the origin of limy bile were discussed.

Discussion:

I. P. FLEMMING-MØLLER: I wish to ask Dr. KNUTSSON if he has observed that the shadows of this limy bile can disappear. Once some years ago I saw what had apparently been a case of limy bile but which had been considered a solitary stone completely filling the gallbladder. The shadow could not be seen on repeated examination about 1 year later and at that time I supposed it must have been a matter of some kind of drug the patient had taken.

XIX. Knut Lindblom, Stockholm: The Contours of the Vessels of the Calvarium.

The 1710 skull examinations carried out at Serafimer Hospital during 1930—32 were used as a basis for this investigation. The normal series consisted of 140 cases of fresh skull trauma. After these were grouped according to sex and age and the width of frontal, parietal and occipital veins, the spheno-parietal sinus and the middle meningeal artery were studied. The remainder of the cases were classified according to the clinical diagnosis (when possible verified by operation or autopsy) and the width of the above mentioned vessels was noted.

The result of the investigation may be summarized as follows:

(1) Normally the vascular spaces are somewhat more distinct in men than in women.

(2) The sphenoparietal sinus or the sphenoparietal diploic veins become more distinct with advancing years, as does the middle meningeal artery up to the third decade.

(3) The vascular spaces are more distinct than normal in organic as well as in functional cerebral diseases. The sphenoparietal sinus or the corresponding diploic veins are especially widened in meningioma, hypophyseal and auditory tumors. The middle meningeal artery is particularly widened in cases of meningioma. There is also considerable widening of these vascular sulci in migraine, arteriosclerosis and trigeminal neuralgia.

(4) More important than these symmetric changes is the asymmetric widening which if definite occurs only in pathological conditions almost without exception. It is found chiefly in cases with cerebral glioma and meningioma. The occipital diploic

veins are affected in cases of tumor of the posterior cranial fossa, especially with auditory tumors.

(5) Glioma as well as meningioma often show a relative increase in the number of vascular sulci in the neighborhood of the tumor.

(6) Increase in the number and size of the Pacchionian bodies parallels to a marked degree the widening of the diploic veins. Large grooves in the occipital bone below the eminence occur chiefly in cerebral glioma, meningioma and tumors of the posterior cranial fossa.

Radiograms were shown to illustrate the different types and degrees of widening of the vascular sulci and diagrams were used to demonstrate mathematically the normal variations and the changes in the contours of the vessels of the calvarium.

XX. B. Lilja, Uppsala: The Situation of Calcification in the Pineal Body in Normal and Pathological Conditions.

The earlier determinations of the situation of the pineal body in normal and pathological conditions were criticized.

A series of röntgen pictures of skulls from the Serafimer Hospital were examined and 200 were gathered which showed calcification in the pineal body. On clinical examination there was no evidence of organic intracranial change or of tumor at least. The normal variability in the situation of the pineal body was statistically established. The position of the pineal body was then determined in 70 cases of Dr. OLIVECRONA's verified tumors. When compared with the normal measurements about 20 % of these pineal bodies were found outside the usual safety limit of normal variation. The material has not yet been completely worked up. Judging from the preliminary figures the method seems to be helpful in determining the existence and location of expansive processes in the brain.

XXI. T. Dale, Oslo: Intracranial Calcification.

The various types of calcification were discussed in case history form with röntgen pictures.

1. *Physiological calcification:* The pineal body, the choriod plexus (two cases of complete calcification of the plexus of all the ventricles were described), the falx cerebri, the attachment of the tentorium and the Pacchionian granulations.

2. *Pathological calcification: Tumors*, Cysts of the cranio-pharyngeal canal have a characteristic calcification which may however be confused with calcification of hypophyseal adenomas, glioma in the chiasm or in the third ventricle. Gliomas, nine cases verified by operation and four probable cases. An angioblastic meningioma, an angioma and an ecchinococcus cust conclude the discussion of verified cases of calcified tumors.

One case of calcified arterio-venous aneurysm diagnosed by arteriogram and cured by operation was described.

In conclusion, post-traumatic, multiple areas of calcification and calcified tuberculomas were mentioned.

The physiological types of calcification are all characteristic. Of the pathological types cysts of the cranio-pharyngeal canal, angiomas, aneurysms and tuberculomas present in many cases a typical calcification. The calcification never gives definite evidence of the size of the tumor.

XXII. Gunnar Jönsson, Stockholm: Röntgenological Changes in Malignant Tumors of the Nasopharynx.

During the last three years 33 cases of malignant tumor of the nasopharynx have been röntgen-examined at Serafimer Hospital. On the basis of the experience obtained from this investigation the author reports the technique which proved best suited for demonstrating tumors of the soft parts of the nasopharynx and the possible areas of bony destruction in the base of the skull. After a short review of the clinical and röntgenological findings in this material the author describes in detail some of the most typical cases. Finally the röntgenological differential diagnosis in cases of malignant tumor of the nasopharynx is discussed.

XXIII. Børge Worning, Hellerup: Röntgen Investigation of Tumors of the Larynx and Hypopharynx.

The author reports on a systematic röntgen-examination made in the course of the last two years of all patients with tumors of the larynx and hypopharynx at the Finsen Institute and the Radium Centre in Copenhagen.

Ossification of the laryngeal cartilage, the picture of the normal larynx and the various ways in which tumors of this region make themselves known are briefly discussed.

Röntgen-examination is used as a supplement to laryngoscopy and throws light on conditions which usually cannot be settled in any other way, namely:

1) The lower border of the tumor.
2) The extent of the tumor behind the larynx.
3) The destruction of the laryngeal cartilage.
4) The early diagnosis of recurrence.

Röntgen-examination of tumors of the larynx and hypopharynx may therefore be considered a useful and often necessary step in the treatment of the disease.

Discussion:

I. J. THORELL: Radiograms of the soft parts of the neck were demonstrated to show the normal variations in the shape of the pharyngeal shadow and the changes in position of the organ with different positions of the tongue. Cases of hypopharyngeal and laryngeal tumor from the Radiumhemmet which were röntgen examined in the Serafimer Hospital were demonstrated.

XXIV. Bertil Ebenius, Stockholm: The Results of Examination of the Petrous Bone in Tumors of the Auditory Nerve.

34 cases of acoustic tumor operated in Dr. OLIVECRONA's neurosurgical clinic in Serafimer Hospital during a 4 year period 1929—1933 have been examined in the Röntgen Department of the hospital. The röntgen technique has been the same in all cases. The internal acoustic meatus has been symmetrically photographed in a frontodorsal and an axial projection.

The result of the investigations in the 34 cases has been as follows:

(1) All the cases have given positive röntgen signs. About 80 % have shown expansive destructive changes in the internal meatus. Areas of destruction due to pressure have been found in the apex or adjacent skeletal parts in 15 %. Only 5 % have not presented local changes in the posterior cranial fossa.

(2) The technique used for examination (a fronto-dorsal and an axial symmetrical projection) is theoretically quite correct and has proven to be superior to other available methods of investigation.

(3) Stenvers' projection is of little value in the investigations in question as the internal meatus does not appear with the desired distinctness on account of the oblique projection.

(4) The width of the internal meatus has shown remarkable variations in the normal material. A difference of 1—3 mm. at the porus was found in 59 % of the cases.

XXV. Arvid Lundquist, Sundsvall: An Examination Table with an Arrangement for a Precision Mechanism.

In order to obtain greater and more accurate possibilities of adjustment, an examination board has been made whose construction depends upon a small apparatus in the form of a clock with rotating hands and logarithmic scales. On these are set the distance between the point to be examined and the film, the film focal distance and the angular setting of the röntgen tube. Then there may be read directly on the scales the exact relative position of the casette and röntgen tube in order that the point to be examined will lie in the middle of the film. On the table are movable scales which automatically give the relative position of the röntgen tube, frame and casette holder on every occasion and these scales are so arranged that they may be controlled at a glance. Adjustment takes place by means of the above mentioned »measuring clock» and with any desired film focal distance the whole surface of the table can be used when making an exact set-up, in contrast to special tables of different construction where all the adjustments are made around one fixed center or around a centrally situated line. The use of the smallest shutter is possible so that the quality of the picture is improved. The supporting frame is movable around 3 sides of the table thus increasing the adjustment possibilities to a considerable degree.

XXVI. Arvid Lundquist, Sundsvall: Apparatus for Stereoscopic Measuring.

The apparatus has been constructed to carry out accurate and completely objective measurements on röntgen pictures. In photographing, two stereoscopic pictures are taken with any base line — preferably exaggerated in order to obtain greater accuracy. The films are placed in the apparatus in two frames above a viewing box. The one frame is fixed, the other is movable. There is a calculator which consists of a number of discs of a special curved shape by which the conversion of logarithmic into metric distances can be made. One puts in on one scale the movement of the röntgen tube between the two exposures (the base line) and on the other scale the film focal distance. The adjustable frame is moved until corresponding points coincide and measurement is made possible. The height of the object above the base is then directly read off an automatically rotating scale. The apparatus can be used for an arbitrarily chosen film focal distance up to $1^1/_2$ meters and with a movement of the röntgen tube up to 15 cm. The

films can be completely measured with the same adjustment of the scales. By including a metal scale in the picture it is not necessary to know the focal distance at the time the picture is taken. It can be determined from tables at the time the measuring is done. There is a correction scale on the apparatus so that the height can be read off directly even if the casette is as much as 10 cm. behind the patient. The accuracy of the apparatus is good and depends chiefly on the sharpness of the radiograms. The management of the apparatus is simple. By adding a suitable arrangement of mirrors it can be used as a stereoscope and stereoscopic measurements can be made. The fields of use are, the determination of the position of foreign bodies and concrements, the relation of different organs to one another, pelvic measurements and the determination of the relative situation of fracture fragments to one another etc.

Discussion:

I. E. LYSHOLM:

II. K. LINDBLOM:

III. A. LUNDQUIST: With reference to Dr. LYSHOLM's point, I wish to call attention to one of my earlier apparatuses for measuring, published with J. HEYMAN in a paper on changes in the symphysis during pregnancy, where the apparatus made possible an automatic set-up according to the principle cited by LYSHOLM. The apparatus I have just described has a definitely greater field of usefulness than the one described by LYSHOLM and it is also considerably simpler to use.

With reference to Dr. LINDBLOM's contribution to the discussion, it may be pointed out that there is a report of the method he mentions in the literature several years ago and it is likewise essentially more complicated than that described by me.

XXVII. Carl Wegelius, Helsingfors: Tridimensional Röntgenological Measurement.

The author confines himself to the measurement of convex bodies and presents a method of correcting the changes in form which are due to the more or less marked oblique position of the photographed planes in relation to the plane of the film. The method depends upon the projections taking place simultaneously or during the same respiratory phase, by means of three different tubes in three planes at right angles to one another. The three shadows thus obtained will be in a three dimensional relation to one another, calculable and for practical use modifiable. The angular position of one plane can be read and measured from the pictures of both the other planes. By optical projection with convergent rays on one plane in such an angular position, the primarily obtained contours are reconstructed to correspond to the actual form and size. The author calls these secondary pictures, »real sections».

The position and angles of the real sections in relation to each other as well as the line where they cut one another can be geometrically determined, thus allowing of their reconstruction in accordance with reality so that a depth picture is obtained with contours in three dimensions.

The series which completes the set, each consisting of 3 real sections each of which determines the other, is obtained by a determinable rotation of the photographic system around the immovable patient and can be fitted into one another in a corresponding way so that the plastic impression is completed.

XXVIII. J. Nielsen, Copenhagen: Röntgenological Studies of Boeck's Disease.

On the basis of the clinical material from the *Finsen Institute* of *Copenhagen* the author describes the various röntgenological alterations in the bones and lungs in *Boeck's disease* (sarcoid) and their evolution. In spite of the morphological variability, the röntgen symptoms are well defined and typical. The etiology has not been disclosed until now. The assumption, that the disease is a special allergic (»anergic«) form of tuberculosis stands unproved. The evident morphological similarity to the alterations in the bones in *leprosy* is stressed. In the opinion of the author the clinical and röntgenological symptoms go to show, that the disease is a specific granuloma, more closely related to leprosy than to tuberculosis.

Discussion:

I. J. Schaumann: I beg to thank Dr. Nielsen for the attention he has shown me by projecting some of the pictures of my microscopic sections of bone-marrow. These pictures are to be found in my paper published in *Ann. de Derm.* 1919, in which the histological alterations in marrow and bone were described for the first time. As I showed there, the pathological process may completely fill the medullary cavities without causing the slightest radiographic alteration. In those cases, on the other hand, where the process led to perceptible lesions, I distinguished *2 radiographic types*, viz., 1): the *osteoporotic*, characterized by enlargement of the osseous lacunae, and 2): the *cavernous*, in which the rarefying phenomena are more pronounced. As I emphasized from the beginning, it is the marrow that forms the starting point of the alterations of the bones. Some authors had previously ascribed these alterations to the skin process, existing above them, going downwards and affecting the bone. In his investigations, in 1921, Gans was unable to show the characteristic granulomatous process; this is not surprising, since his investigation material consisted of nothing but a thin plate of bone which had been extirpated together with a skin lesion. It is with satisfaction that I see in the relevant literature that, since my proposal, röntgenography of the hands and feet is rarely omitted nowadays to confirm the diagnosis, because it is not unusual that radiological alterations in the bone may be discovered although they give no clinical signs.

On the other hand, röntgenograms may give us no assistance at all, since, as I have mentioned, the process may invade the entire medullary cavity without in any way modifying the osseous substance. I therefore whenever possible, make a microscopic examination of the tonsils too. In every instance in which I did this in an active stage (18 cases at least), I found that the tonsils were the seat of the characteristic granulomatous alterations. Such an examination may be of great importance when it is a question of distinguishing lupus pernio and cutaneous sarcoids from certain cases of lupus vulgaris, lupus erythematosus and sarcoid-like affections.

The mentioned radiological pulmonary alterations, on the other hand, are scarcely of any assistance for diagnostical purposes, unless we happen to have some other knowledge of the case in question. I shall take the liberty of projecting here the radiogram of the lungs in which such alterations were found for the very first time, and were interpreted as being of the same nature as the disease in question. The radiogram, which shows these abundant shadowy spots dispersed symmetrically in the two lungs, and concentrated towards the hilus, where the glands are increased in size, was taken by Professor Forssell and, together with a couple of similar radiograms, was reproduced

in my paper of 1914. In the German literature, the priority of the discovery of these pulmonary alterations has been erroneously ascribed to KUTZNITZKY and BITTORF.

When, in 1914, I ascribed the pulmonary lesions found by radiological investigation to the disease in question, my view of the matter was hypothetical, based, as it was, on their insensibility to large doses of tuberculin, and on our knowledge of the not infrequent localization of lymphadenic affections in the lungs. Quite recently I had an opportunity of confirming histologically the correctness of this presumed identity, at the autopsy of a pure case of Boeck's sarcoid of the miliary disseminated type. The patient was a man, 45 years of age, in whom during life the process had been shown microscopically in the skin and tonsils, and radiologically in the form of shadowy spots dispersed throughout the lungs. In the microscopic section from the lungs projected here, there is visible a group of the circumscribed epithelioid tubercles which are characteristic of the disease and which are localized in an interalveolar septum; they exhibit no necrosis and only a very inconsiderable lymphoid reaction. The next lantern slide shows a similar group with a somewhat more pronounced lymphoid zone. In projection 3, we see how such a group, entirely filling a pulmonary alveolus, consists, for the most part, of hyalin connective tissue. Number 4, originating from the central parts of the lung, presents a rather large conglomerate of epithelioid tubercles and tubercles of a more fibrous nature. It is, of course, these non-aeriferous formations which produce the dispersed shadowy spots on the radiogram of the lung. — The pleura, which was thickened, also displayed areas of the characteristic epithelioid foci.

My assumption of the occurrence of the disease in other internal organs as well, proved to be correct. The spleen, for instance, which was more than 3 times enlarged and weighed 490 grams was the seat of foci of the above-mentioned epithelioid type, often with hyalin transformation. The structure of the spleen was considerably altered, and the tissue was rich in lymphoid cells and plasma cells. The Malpighian bodies were few and atrophied. The characteristic epithelioid tubercles without necrosis were found in the spleen capsule as well.

Similar tubercles, although not so numerous, were found in the liver. The organ was enlarged (2,500 grammes) and also displayed cirrhotic alterations.

I have not as yet observed the distinctive lesions of the disease in the renal parenchyma, but they were found in the renal capsule.

The bronchial glands and all the lymphatic glands of the abdominal cavity (those in the hilus of the spleen and of the liver; the mesenterial, the retroperitoneal and the iliac) were moderately enlarged and formed seats of the epithelioid tubercles, frequently in hyalin transformation.

This disease, of which certain manifestations, in particular the cutaneous, were first described by BESNIER (1889) and later by BOECK (1899), is consequently not situated merely in the peripheral lymphoglandular system, the tonsils and the bone-marrow, as I have previously demonstrated, but has also been found in the glands of the abdominal cavity and chest, in the spleen and the liver, and in the lungs and the kidneys, as was shown by my investigation of the above-mentioned unique autopsy case. It therefore shows a predilection for the same organs as lymphadenic affections. It appears to me, therefore, that there is more reason than ever to call this, on the whole, benign granulomatous disease, the exact nature of which has not yet been definitely determined, by the anatomico-clinical name *benign lymphogranuloma*. Boeck has displayed keen penetration in isolating and studying the cutaneous sarcoids, and it is with justice that they bear his name, but the term »Boeck's disease» is not supported by the actual facts.

[A more detailed account of the autopsy case described above is to be found in *Bull. de la Soc. Franç. de Derm.*, July 1933, p. 1167. (R. S.)]

XXIX. K. Bruno Jäderholm, Stockholm: Investigations of Skin Dose in Röntgen Diagnosis.

In the Röntgen Department of Maria Hospital, Stockholm, some investigations of skin dose in the most usual röntgen examinations were undertaken by means of SIEVERT's measuring chambers.

The röntgen examinations have been carried out by a trained personnel so that the time of fluoroscopy is short and the number of exposures few.

In examination of the stomach with a 1 mm. Al filter the largest amount of radiation was found to be 64 r and the lowest 9 r. In similar examinations with a 2 mm. Al filter the highest value was 24 r and the lowest 11 r. In colon examinations the corresponding values were 25 r and 14 r. When 3 large radiograms of the entire abdomen were taken the highest radiation obtained on the skin of the abdomen was 22 r.

Thus in a single investigation the skin dose was small but the risk of skin effect when several investigations were combined was pointed out.

The skin dose was most effectively decreased by shortening the time of fluoroscopy and by taking as few radiograms as possible. The investigations should be carried out by well trained workers so that the results will not suffer. The importance of not working with a too short skin-focus distance was pointed out as well as the advantage of using a 2 mm. Al filter for examinations of the denser parts of the body such as the stomach and other abdominal organs by means of a contrast meal.

XXX. T. Dale, Oslo: Experiments with Enlargement of Röntgen Pictures.

Röntgen picture of a rabbit's ear with the arteries and veins filled with contrast material were enlarged fifty times (lineal enlargement). The pre-capillary vessels became visible. The film used was very finely granular and only slightly sensitive to röntgen rays. Further enlargement is not possible with the photographic emulsion at present available.

XXXI. B. Lilja, Uppsala: The Causes of Meteorism with Special Reference to its Occurrence with Pyelography.

In röntgen examination of the abdomen one finds a varying amount of gas in the intestines. The intra-intestinal gas comes partly from air swallowed with the food and partly from chemical fermentation and bacterial processes which bring about the breakdown of the food; in addition carbonic acid from the blood and surrounding tissues can diffuse over into the intestinal lumen. Only an insignificant part of the gas is gotten rid of in a natural way, the main part is absorbed by the blood and excreted through the lungs. LAURELL has described meteorism with a number of different clinical conditions, which had in common the presence of circulatory disturbances, so that a disturbance in gas resorption existed. WAHREN has shown experimentally that alterations in resorption are the dominating factor in the origin of meteorism. In meteorism with cystoscopy and pyelography, the trauma from the instrumental procedure should be of decisive importance. This causes circulatory disturbances with resulting changes in gas re-

sorption. Clinical experiences with meteorism after abdominal trauma and the experimental investigations of WAHREN support this conception.

Finally the question of purgation before röntgen examination was discussed and it was especially pointed out that possible existing circulatory disturbances could certainly be important in the origin of meteorism and these could not be removed by purgation.

Discussion:

I. W. MAGNUSSON: The speaker referred to a previous paper on meteorism with pyelography and showed pictures from this investigation. Cases of meteorism with rapid onset during pyelography could only be explained by supposing that the air was swallowed, because one could not imagine that such large quantities of gas could appear in such a short time by means of diffusion. Gas formation from the chemical breakdown of intestinal and gastric contents is reduced to a very insignificant amount in fasting patients.

II. B. LILJA: I have already pointed out in my lecture that Dr. MAGNUSSON has conclusively shown that meteorism can arise from forced swallowing of air. As I also mentioned, however, there are a number of clinical conditions where meteorism develops on this basis of circulatory disturbances and it has been shown experimentally that the meteorism is chiefly due to a faulty resorption which also occurs in certain traumatic conditions. Therefore I think there is no reason to isolate the meteorism following pyelography as a special condition which develops in a different way. It seems quite natural to me that a disturbance in carbonic acid resorption and diffusion conditions can quickly bring about meteorism even in a fasting patient; carbonic acid is a gas which occurs in the body in large quantities both in a dissolved and gaseous form.

It is probable that here as well as in many biological processes there can be several factors at work together. I think that swallowing of air certainly can play a rôle in some cases. I consider, however, that circulatory disturbances are the dominating factor in the origin of meteorism in connection with cystoscopy and pyelography.

XXXII. A. Lundquist, Sundsvall: Investigations of the Effect of Different Intensifying Screens.

The investigations comprise comparative measurements of the intensifying effect of 28 of the different kinds of intensifying screens on the market, with tensions varying between 40 and 105 kv. The different effects of anterior and posterior screens were studied. The comparatively great absorption with anterior screens was compared for the different makes. With low tensions only the posterior screen in many types gave greater blackening effect than both screens together. The chief difference in the degree of effect between the usual folios and combination folios was investigated. A diagram has been drawn up on which one can read off the most favorable tension for different screens in order to obtain a certain blackening with different filtration. This may be used practically to find the most suitable tension for photographing different organs. The reciprocal significance of both of the photographic layers in films with different blackening has been measured with exposure with and without folios and with only an anterior or posterior folio.

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STADGAR FÖR NORDISK FÖRENING FÖR MEDICINSK RADIOLOGI

antagna vid Föreningens 7:e möte i Stockholm den 1 juli 1933

§ 1.

»*Nordisk Förening för Medicinsk Radiologi*» utgör en sammanslutning av föreningarna för medicinsk radiologi i Danmark, Finland, Island, Norge och Sverige.

§ 2.

Föreningens ändamål är att verka för den medicinska radiologiens utveckling samt att mottaga och förvalta medel, som för befordrande av nämnda ändamål ställas till dess förfogande. Sitt ändamål söker Föreningen förverkliga särskilt genom att anordna möten mellan Nordens radiologer för meddelande av vetenskapliga rön och för kamratligt umgänge.

§ 3.

Föreningen består av medlemmar, korresponderande medlemmar och hedersmedlemmar.

§ 4.

Medlem av Nordisk Förening för Medicinsk Radiologi (N. F. f. M. R.) är varje medlem av föreningarna för medicinsk radiologi i Danmark, Finland, Island, Norge och Sverige.

§ 5.

Till hedersmedlemmar eller korresponderande medlemmar kunna väljas personer inom och utom de till Föreningen anslutna länderna, vilka Föreningen önskar giva sitt erkännande för utmärkta förtjänster inom radiologien.

§ 6.

Föreningens styrelse skall bestå av dels ordförandena i de till Föreningen anslutna nationella radiologföreningarna, dels ytterligare minst nio, högst elva, medlemmar, nämligen minst tre från det land, där nästa möte skall hållas, och minst två från vart och ett av de övriga länderna. Dessa styrelsemedlemmar väljas av N. F. f. M. R. för tiden till och med nästa möte och kunna omväljas.

§ 7.

Styrelsens ämbetsperiod varar från den första januari året näst efter det år, då styrelseval ägt rum, till den sista december det år, då följande möte äger rum.

§ 8.

Bland styrelsens medlemmar väljer Föreningen en president, en generalsekreterare och en skattmästare. Presidenten och generalsekreteraren skola utses bland representanterna för det land, där Föreningen beslutat att hålla nästa möte.

§ 9.

Skulle någon av de av Föreningen valda styrelsemedlemmarna avgå under tiden mellan tvenne möten, äger styrelsen att själv utse ställföreträdare.

§ 10.

Styrelsen handhaver i enlighet med dessa stadgar Föreningens angelägenheter och förvaltar dess tillgångar; förbereder ärenden, som skola föreläggas Föreningen, samt talar och svarar å Föreningens vägnar inför domstolar och andra myndigheter.

Styrelsen bestämmer mötesavgiften, som meddelas i mötets program.

Styrelsen avger till Föreningen förslag till val av hedersmedlemmar och korresponderande medlemmar, och skall sådant förslag beslutas med $^2/_3$ majoritet för att kunna föreläggas Föreningen.

§ 11.

Styrelsen håller ordinarie sammanträde dagen före varje föreningsmöte på tid och plats, som ordföranden bestämmer.

Extra styrelsesammanträde äger rum, då ordföranden anser ärendena det fordra, ävensom när minst fyra av styrelsens övriga medlemmar skriftligen gjort anhållan därom. Kallelse till extra styrelsesammanträde, som ej hålles under pågående möte, utfärdas av ordföranden minst en vecka före sammanträdet.

§ 12.

Styrelsen är beslutmässig, när minst sju av dess medlemmar, representerande minst tre nationer, deltaga i beslutet. Vid lika röstetal äger ordföranden utslagsröst. Styrelsens beslut kunna fattas per capsulam. För att sådant beslut skall vara giltigt fordras att minst två tredjedelar av styrelsens medlemmar biträder detsamma. Protokollen över styrelsens sammanträden justeras av ordföranden. Avskrift av styrelsens protokoll skall tillställas ordförandena i de anslutna föreningarne.

§ 13.

Presidenten och generalsekreteraren bilda styrelsens arbetsutskott.

Arbetsutskottet åligger: *att* bereda viktiga ärenden, innan de föreläggas styrelsen, samt *att* förbereda Föreningens möten enligt av Föreningen fastställd arbetsordning.

§ 14.

Föreningens namn tecknas å viktigare skrivelser och andra handlingar av presidenten och generalsekreteraren tillsammans.

§ 15.

Presidenten åligger: *att* representera Föreningen och föra dess talan; *att* tillse att Föreningens verksamhet motsvarar dess uppgift; *att* utlysa styrelsens sammanträden och Föreningens extra sammanträden samt att leda förhandlingarna vid Föreningens och styrelsens sammanträden.

§ 16.

Generalsekreteraren åligger: *att* föra protokoll vid Föreningens och styrelsens sammanträden; *att* ombesörja Föreningens korrespondens och meddelanden angående Föreningen; *att* mellan styrelsens sammanträden ombesörja Föreningens löpande ärenden samt vid nästa styrelsesammanträde anmäla åtgärder, som sålunda vidtagits; *att* förvara och diarieföra Föreningens och styrelsens protokoll och korrespondens; *att* redigera Föreningens vetenskapliga förhandlingar.

§ 17.

Skattmästaren åligger: *att* hava under sin vård Föreningens säkerhetshandlingar, kassor, verifikationer och övriga handlingar; *att* handhava förvaltningen av Föreningens medel i enlighet med styrelsens beslut; *att* över Föreningens inkomster och utgifter föra noggranna räkenskaper; *att* mottaga medlemsavgifter samt föra förteckning över dem som erlagt avgift; *att* i behörig ordning verkställa beslutade utbetalningar; *att* före utgången av april månad till styrelsen inkomma med förslag till inkomst- och utgiftsstat för följande arbetsår. Skattmästaren äger vid uttagning från Föreningens bankräkningar, vid utkvitterande av värdeförsändelser och vid andra liknande tillfällen ensam teckna Föreningens namn.

§ 18.

Varje medlem av Föreningen äger att hos styrelsen framställa förslag rörande handhavandet av Föreningens angelägenheter; det åligger styrelsen att snarast taga dylikt förslag under prövning. Sådant förslag, avsett att vid nästkommande ordinarie föreningssammanträde prövas, skall, skriftligen avfattat, inlämnas till styrelsen senast 2 månader före föreningsmöte.

§ 19.

Föreningens räkenskaper skola avslutas för kalenderår och före utgången av april månad nästkommande år tillhandahållas Föreningens revisorer.

§ 20.

Styrelsens förvaltning och Föreningens räkenskaper skola för varje kalenderår granskas av två revisorer, av vilka den ena skall vara yrkesutbildad revisor.

Revisorerna, jämte två suppleanter för dem, utses för styrelsens ämbetsperiod.

§ 21.

Till Föreningens möte avgiver styrelsen berättelse över sin förvaltningsperiod samt framlägger av revisorerna avgivna berättelser ävensom utredning i alla ärenden, som skola av Föreningen avgöras.

§ 22.

Föreningen sammanträder till ordinarie möte i regel vart tredje år å tid och plats, som av Föreningen bestämmes vid närmast föregående möte. Dock böra mötena, om ej särskilda hinder föreligga, hållas i juni månad.

Extra sammanträde av Föreningen kan äga rum, om styrelsen finner ärendena det fordra. Kallelse till sådant sammanträde utfärdas minst en månad i förväg.

§ 23.

Vid Föreningens sammanträden har varje medlem en röst.

Röst får icke överlåtas, ej heller får medlem rösta genom fullmakt.

Alla val och omröstningar vid Föreningens möten skola vara öppna, därest ej sluten omröstning begäres.

Vid omröstning gäller enkel pluralitet. Utfalla rösterna lika, gälle ordförandens mening, utom i fråga om val, då utgången bestämmes genom lottning.

§ 24.

Årsavgiften för Föreningens medlemmar utgör 5 kronor eller 50 Fmk och erlägges i resp. lands mynt. Årsavgiften inkasseras av skattmästaren i de till Föreningen anslutna nationella radiologföreningarna i januari månad varje år och tillställas skattmästaren för N. F. f. M. R. före utgången av mars månad jämte förteckning över dåvarande medlemmar i de resp. föreningarna med angivande av de medlemmar, som erlagt avgift.

Hedersmedlemmar och korresponderande medlemmar äro befriade från årsavgift.

§ 25.

Vid Föreningens möten skola förekomma dels föreningssammanträden, dels vetenskapliga förhandlingar, dels kamratliga samkväm.

§ 26.

Tvenne föreningssammanträden skola hållas vid varje möte, nämligen ett öppningssammanträde den första dagen och ett avslutningssammanträde den sista dagen av varje möte. Vid föreningssammanträdena skola ärenden, som röra Föreningens organisation, ledning och förvaltning, behandlas och avgöras.

§ 27.

Vid öppningssammanträdet skola följande ärenden förekomma: Val av en hederspresident och en kongressekreterare från var och en av de anslutna radiologföreningarna, att biträda vid mötets vetenskapliga förhandlingar; styrelsens berättelse; revisionsberättelse och fråga om ansvarsfrihet åt styrelsen; ärenden, som i övrigt förekomma enl. §§ 5, 10, 18 och 32; val av en justeringsman att jämte presidenten justera dagens protokoll.

§ 28.

Vid avslutningssammanträdet skola följande ärenden förekomma: Bestämmande av plats, tidpunkt och allmän arbetsordning för nästa möte; val av medlemmar i styrelsen enligt § 6; val av president, generalsekreterare och skattmästare; val av två revisorer och två revisorssuppleanter; föreningsärenden enligt §§ 5, 10, 18 och 32; val av en justeringsman att jämte presidenten justera dagens protokoll.

§ 29.

Föreningens vetenskapliga förhandlingar omfatta föredrag, diskussioner och demonstrationer i radiologiska ämnen och äga rum enligt av styrelsen för varje möte uppgjord arbetsordning. Tillträde till de vetenskapliga förhandlingarna kan av ordföranden medgivas icke-medlemmar av Föreningen.

§ 30.

Mötenas kamratliga samkväm ordnas enligt av Föreningen godkänd arbetsordning.

§ 31.

Dessa stadgar kompletteras genom en arbetsordning för Föreningens möten.

§ 32.

Önskar medlem av Föreningen väcka förslag om ändring av dessa stadgar, skall förslaget senast en månad före föreningsmöte skriftligen tillställas styrelsen, som äger att med eget yttrande framlägga förslaget till avgörande vid föreningssammanträde.

Av styrelsen väckt förslag till stadgeändring skall skriftligen framläggas till beslut vid föreningssammanträde.

Beslut om stadgeändring fordrar bifall av minst $^2/_3$ av de avgivna rösterna för att anses giltigt.

§ 33.

Upplösning av Föreningen kan endast äga rum genom beslut av tre fjärdelar av vid föreningssammanträde närvarande medlemmar och måste för att erhålla giltighet bekräftas å särskilt för detta ändamål inom ett år utlyst möte, ävenledes med $^3/_4$ majoritet. Vid detta senare möte skall i händelse av Föreningens upplösning bestämmelse träffas om användning av Föreningens förmögenhet och övriga tillgångar.

ALLMÄN ARBETSORDNING FÖR MÖTEN AV NORDISK FÖRENING FÖR MEDICINSK RADIOLOGI

1. Föreningens möten hållas omväxlande i Finland, Danmark, Norge och Sverige.
2. Styrelsen uppställer ett eller flera diskussionsämnen för nästa möte och utser senast två år före nästa möte inledare för dessa diskussioner.
   Det är önskvärt, att inledningsföredragen utdelas tryckta såsom korrektur till artiklar i Acta radiologica en månad före varje mötes början.
3. Från varje land inbjuder styrelsen en föredragshållare att hålla ett längre föredrag (45 min.) över något aktuellt forskningsområde.
4. Tiden för övriga föredrag bestämmes till 20 minuter. Tiden för diskussionsinlägg bestämmes av styrelsen.
5. Förberedande program för mötet med angivande av ev. diskussionsämnen och inbjudna föredrag tillställes samtliga medlemmar av Föreningen senast ett år och preliminärt program senast sex veckor före mötet.
6. Protokollen från Föreningens sammanträden och dess vetenskapliga förhandlingar offentliggöras i Acta radiologica.
7. De vid de vetenskapliga förhandlingarna hållna föredragen offentliggöras, såvitt möjligt, på så sätt, att desamma i sin helhet införas såsom artiklar i Acta radiologica. Endast en kort resumé av föredragen — på engelska — tryckes i mötets förhandlingar, under det att däremot diskussionsinläggen — på engelska — införas in extenso.
8. Resuméer och diskussionsinlägg skola överlämnas till generalsekreteraren före pågående mötets utgång. I annat fall kunna de ej tryckas i förhandlingarna.
9. Mötesavgiften, som för varje möte bestämmes av styrelsen, avser att täcka mötets lokal- och övriga organisations- och förvaltningskostnader.

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IV. INTERNATIONALER RADIOLOGENKONGRESS
ZÜRICH 24.—31. JULI 1934 — MITTEILUNG No 2

Präsident: Prof. Dr. H. R. SCHINZ

Generalsekretär: Dr. Med. H. E. WALTHER, Zürich, Gloriastrasse 14

An der Eröffnungssitzung spricht Professor *Gösta Forssell* über die *Organisation der Krebsbekämpfung* im allgemeinen. Weitere Referenten berichten über die Krebsbekämpfung in den verschiedenen Ländern.

Programm der wissenschaftlichen HAUPTVERHANDLUNGEN:

	Referent:	Korreferenten:
Röntgendiagnostik der Knochentumoren	Kienböck-Wien	Bloodgood-Baltimore, Gassul-Kasan, Mathey-Cornat-Bordeaux
Die Lungentuberkulose im Röntgenbild	Herrnheiser-Prag	Assmann-Königsberg, Braeuning-Stettin, Fleischner-Wien, Maragliano-Genua, Melville-London
Strahlenbehandlung der Uteruskarzinome	Lacassagne-Paris	Heyman-Stockholm, Regaud-Paris, Schmitz-Chicago, Voltz-München. Wintz-Erlangen
Strahlenbehandlung der Mundhöhlen- und Pharynxkarzinome	Perussia-Mailand	Berven-Stockholm, Coutard-Paris, Finzi-London, Pfahler-Philadelphia, Quick-New York
Strahlengenetik	Muller-Austin-Texas	Stubbe-Müncheberg, Timoféeff-Ressovsky-Berlin
Mitogenetische Strahlung	Gurwitsch-Moskau	Friedrich-Berlin, Rajewski-Frankfurt/M., Salkind-Moskau
Strukturanalyse	Bragg-Manchester	Debye-Leipzig, Ewald-Stuttgart
Das Problem der Vereinheitlichung der Physikalischen Dosierung bei der Radium- und Röntgenbehandlung	Holthusen-Hamburg	Baastrup-Kopenhagen, Failla-New York, Mallet-Paris, Murdoch-Brüssel, Mrs. Quimby-New York, Risse-Freiburg/Br.
Die harte Gammastrahlung und die durchdringende Strahlung irdischen und kosmischen Ursprungs	Sievert-Stockholm	Gerlach-München, Hess-Innsbruck. Kolhörster-Berlin, Piccard-Brüssel
Kurzwellentherapie	Carelli-Buenos Aires	Dausset-Paris, Réchou-Bordeaux, Schliephake-Giessen.

Für Anmeldung von Vorträgen in den Sektionssitzungen ist als letzter Termin der 1. Januar 1934 festgesetzt worden. Die Vortragsliste wird in einem weiteren Zirkulare nach Schluss der Anmeldefrist bekanntgegeben werden.

Die gesellschaftlichen Veranstaltungen des Kongresses werden sich in dem bisher üblichen Rahmen halten. Neben dem offiziellen Empfang und dem Schlussbankett bereitet ein besonderes Komitee einen festlichen Anlass vor, bei dem den Kongressteilnehmern Sitten und Gebräuche, alte und neue Trachten der verschiedenen Schweizerkantone vorgeführt werden.

NEWS ON THE BOOKSHELF

A. E. Barclay: The Digestive Tract. Cambridge University Press. London 1933.

Alexandre Espaillat-G.: L'étude radiographiqne du sein normal et pathologique. Louis Arnette. Paris 1933.

G. Chaumet: Traité de Radiodiagnostic: Appareil respiratoire, cœur et gros vaisseaux. Vigot Frères, Éditeurs, Paris 1933.

Robert Kienböck: Röntgendiagnostik der Knochen- und Gelenkkrankheiten. Heft 1: Differentialdiagnose der geschwulstigen Knochenkrankheiten; Heft 2: Knochenechinokokkose. Urban & Schwarzenberg. Wien 1933.

Manuel & Francisco Arce: Radiodiagnostico en la Infancia. Ediciones Boro. Madrid 1933.

François Fieschi: Ionothérapie électrique et haute fréquence. Vigot Frères, Éditeurs. Paris 1933.

R. Claoué: Le Nystagmus Vestibulaire et les Réactions de mouvements. Éditions médicales Norbert Maloine. Paris 1933.

D. Gutierrez Arrese, M. & F. Arce: Exploration Radiologica de la Peritonitis tuberculosa. Archivos de Medicina. Cirugia y Especialidades. Madrid 1933.

Annibal Varges: Galvanodiathermie, Galvanodiathermothérapie, Galvanodiathermoionothérapie. Éditeurs Villani & Barbero. Rio de Janeiro 1932.

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G. F. Haenisch & H. Holthusen: Einführung in die Röntgenologie. Ein Lehrbuch für Ärzte und Studierende. Georg Thieme, Verlag. Leipzig 1933.

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W. Roy Ward & A. J. Durden Smith: Recent Advances in Radium. J. & A. Churchill, London 1933.

Virgilio Dall'Acqua: La Mucosa Gastro-Duodenale Negli Stati Normali e Patologici, Studi Radiologici. Edizioni Minerva Medica. Torino 1933.

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* The *full-faced* figures refer to *original articles*.

Supplements to the
ACTA RADIOLOGICA

Supplementum I. Åke Åkerlund: Röntgenologische Studien über den Bulbus Duodeni. (Out of print).

Supplementum II. Gösta Forssell: On the Permanency of Radiological Healing in Malignant Tumours. Price bound Sw. cr. 10: —; unbound Sw. cr. 8: —.

Supplementum III. An Account of the Second International Congress of Radiology, held in Stockholm, July 23 rd—27 th, 1928, Proceedings of the Joint Scientific Meetings of the Congress on July 25 th, 26 th, and 27 th, 1928, and Abstracts of Communications at the Congress. Price Sw. cr. 20: —, for members of the Congress Sw. cr. 15: —.

Supplementum IV. Teaching and Training in Medical Radiology. Papers delivered at the Second International Congress of Radiology, in Stockholm, July 24 th, 1928, by representatives of 23 countries. Price Sw. cr. 30: —, for members of the Congress Sw. cr. 20: —.

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